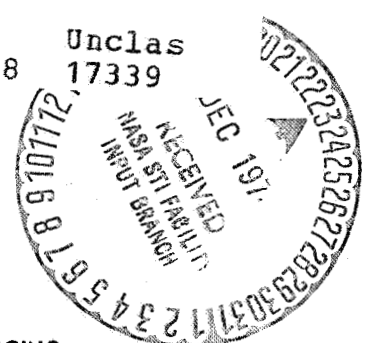
MSC-PA-R-68-9
Supplement 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 6 MISSION REPORT

TRAJECTORY RECONSTRUCTION AND ANALYSIS



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MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
September 1968

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Supplement 1

APOLLO 6 MISSION REPORT

TRAJECTORY RECONSTRUCTION AND ANALYSIS

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PROJECT APOLLO
TASK MSC/TRW A-50

APOLLO MISSION 6, AS-502 TRAJECTORY RECONSTRUCTION AND POSTFLIGHT ANALYSIS - VOLUME I

15 JULY 1968

Prepared for
MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
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NAS 9-4810

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FOREWORD

This report is submitted to the NASA Manned Spacecraft Center in accordance with Task MSC/TRW A-50.3 Contract NAS 9-4810. This report contains the postflight analysis performed in conjunction with the flight of Apollo Mission 6, AS-502, and is issued as a supplement to Section 3, Trajectory Section, of the Apollo 6 Program Mission Report.

The report is issued in two volumes. Volume I contains details of the analysis and results obtained, including appendices. Volume II contains a listing of the "45 Day" best estimated trajectory (BET) for the AS-502 mission in the NASA Apollo Trajectory (NAT) format which is shown below. The listing is not generally distributed, but is available from NASA/MSC upon request. Requests should be made to:

NASA/MSC Computations and Analysis Division
Central Metric Data File
Code ED-5, Bldg. 12, Room 133
Houston, Texas 77058

The listing is in four parts which are identified by time span covered and the corresponding accession number.

	Time Span (GET)	Accession No.
Part I	03:13:21 - 04:07:29	06-05923
Part II	04:07:59 - 07:26:29	06-05924
Part III	07:26:59 - 09:50:18.6	06-05925
Part IV	09:50:20.6 - 09:57:20.6	06-05926

NASA APOLLO TRAJECTORY INDEX

1	GMTR SECONDS	GMTC SECONDS	GMTC HOURS	GETS SECONDS		GRR SECONDS	GMTC HR MIN SEC
9	GEOCENTRIC LATITUDE DEGREES	GEODETIC LATITUDE DEGREES	GEODETIC LONGITUDE DEGREES	GEODETIC ALTITUDE FEET	INERTIAL VELOCITY FEET/SEC	INERTIAL PATH ANGLE DEGREES	INERTIAL HEADING DEGREES
15	DECLINATION DEGREES	ORBIT RADIUS FEET	RADIUS DERIVATIVE FEET/SEC	GEOCENTRIC ALTITUDE FEET	RELATIVE VELOCITY FEET/SEC	RELATIVE PATH ANGLE DEGREES	RELATIVE HEADING DEGREES
22	(BLANK)	CENTRAL ANGLE DEGREES	HORIZON ANGLE DEGREES	SUN THETA DEGREES	SUN PHI DEGREES	GROUND RANGE NMI	DISTANCE TRAVELED NMI
29	X ECI FEET	Y ECI FEET	Z ECI FEET	XDOT ECI FEET/SEC	YDOT ECI FEET/SEC	ZDOT ECI FEET/SEC	G SUB X FEET/SEC**2
36	X ECIG FEET	Y ECIG FEET	Z ECIG FEET	XDOT ECIG FEET/SEC	YDOT ECIG FEET/SEC	ZDOT ECIG FEET/SEC	G SUB Y FEET/SEC**2
43	X AGC FEET	Y AGC FEET	Z AGC FEET	XDOT AGC FEET/SEC	YDOT AGC FEET/SEC	ZDOT AGC FEET/SEC	G SUB Z FEET/SEC**2
50	P E SF FEET	Q ESF FEET	R ESF FEET	PDOT ESF FEET/SEC	QDOT ESF FEET/SEC	RDOT ESF FEET/SEC	G TOTAL FEET/SEC**2
57	U ECF FEET	V ECF FEET	W ECF FEET	UDDOT ECF FEET/SEC**2	VDDOT ECF FEET/SEC**2	WDDOT ECF FEET/SEC**2	ORBIT
64	XDDOT ECI FEET/SEC**2	YDDOT ECI FEET/SEC**2	ZDDOT ECI FEET/SEC**2	XDDOT ECIG FEET/SEC**2	YDDOT ECIG FEET/SEC**2	ZDDOT ECIG FEET/SEC**2	REVOLUTION
71	XDDOT AGC FEET/SEC**2	YDDOT AGC FEET/SEC**2	ZDDOT AGC FEET/SEC**2	APOGEE RADIUS FEET	PERIGEE RADIUS FEET	APOGEE ALTITUDE NMI	PERIGEE ALTITUDE NMI
78	SEMI-MAJOR AXIS FEET	SEMI-MINOR AXIS FEET	ECCENTRICITY	INCLINATION DEGREES	RT. ASCEN. NODE, AIRES DEGREES	ARGUMENT PERIGEE DEGREES	TRUE ANOMALY DEGREES
85	PERIOD MINUTES	RT. ASCEN. SAT., GRNWCH DEGREES	RT. ASCEN. SAT., ARIES DEGREES	(BLANK)	RT. ASCEN. NODE, GRNWCH DEGREES	ECCENTRIC ANOMALY DEGREES	MEAN ANOMALY DEGREES
92	(BLANK)	SEMI-LATUS RECTUM FEET	SPEED OF SOUND FEET/SEC	MACH NUMBER	DYNAMIC PRESSURE LB/FT**2	REYNOLDS NUMBER	TOTAL ENERGY FT-LBS
99	ATMOSPHERIC DENSITY SLUGS/FT**3	ATMOSPHERIC PRESSURE LB/IN**2	TEMPERATURE DEGREES RANKINE	XDDOT PIPA FEET/SEC**2	YDDOT PIPA FEET/SEC**2	ZDDOT PIPA FEET/SEC**2	PIPA TOTAL ACCELERATION FEET/SEC**2
106	XDOT PIPA FEET/SEC	YDOT PIPA FEET/SEC	ZDOT PIPA FEET/SEC	PIPA TOTAL VELOCITY FEET/SEC	AERODYNAMIC VELOCITY FEET/SEC	AERODYNAMIC PATH ANGLE DEGREES	AERODYNAMIC HEADING DEGREES
113	XDOT ESF WIND CORR. FEET/SEC	YDOT ESF WIND CORR. FEET/SEC	ZDOT ESF WIND CORR. FEET/SEC	WIND SPEED FEET/SEC	WIND DIRECTION DEGREES		

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TABLES

ILLUSTRATIONS

3. APOLLO MISSION 6, AS-502 TRAJECTORY RECONSTRUCTION AND POSTFLIGHT ANALYSIS

3.1 INTRODUCTION AND SUMMARY

The Apollo 6 mission was launched from complex 39 A at Cape Kennedy, Florida, on 4 April 1966. Range zero was established at 12:00:01 Greenwich mean time (GMT) with command service module (CSM) guidance reference release (GRR) occurring 1.15 seconds later. Parking orbit insertion occurred at 12 minutes 37.04 seconds ground elapsed time (GET). Restart of the S-IVB for the second burn failed, and S-IVB/CSM separation was effected at 3 hours 14 minutes 27.8 seconds GET. An alternate mission plan was effected whereby the SPS-1 burn was used to inject the spacecraft into a high-apogee, earth-intersecting ellipse. At approximately 6 hours 28 minutes 57.05 seconds GET, the spacecraft reached an apogee of 12,019.57 nautical miles. There was no SPS-2 burn, although a preprogrammed ullage occurred. The command module entered the earth's atmosphere at approximately 9 hours 38 minutes 28 seconds GET, and splashdown occurred at approximately 9 hours 57 minutes 18 seconds GET.

Figure 3-1 presents the AS-502 mission timeline and tracking coverage after S-IVB/CSM separation.

3.2 ASCENT ANALYSIS AND SPS BURN RECONSTRUCTION

3.2.1 Analysis of IMU From Ascent Data

Analysis of IMU errors consists of determining a physically acceptable set of instrument errors to bring the trajectory as measured by the Apollo IMU into agreement with the best estimate of the actual trajectory flown. During the boost phase there were nine trajectories available from which to choose a standard. Six of these were generated by MSFC from the S-IVB Instrument Unit (IU) telemetry data. These six represented an evolution from the raw IU data to a final S-IVB BET designated as Final "Observed Mass Point Trajectory," (OMPT), the MSFC BET. The three remaining trajectories represent a similar evolution in the processing of GLOTRAC radar data. Since valid GLOTRAC data were available to

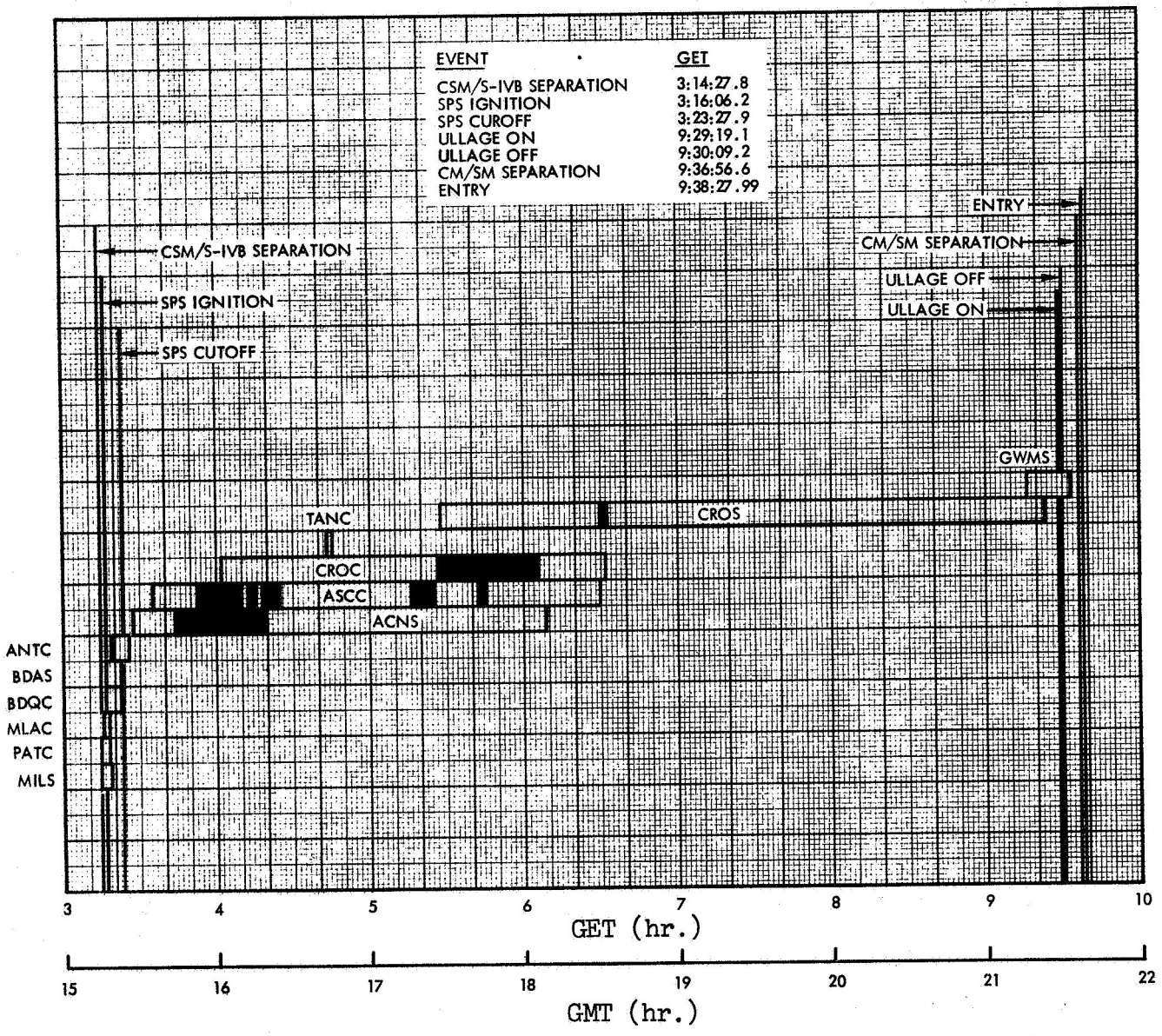

Figure 3-1. Timeline of Major Events and Radar Tracking Coverage

compare with Apollo telemetry only during the interval from 26 to 84 seconds, the Marshall OMPT was initially chosen as BET during boost. An extensive effort was made to select a reasonable set of error values to reduce the Apollo G&N minus OMPT position and velocity residuals to reasonable values.

No reasonable set of errors was found which effected a good boost comparison with this trajectory and also yielded a good state vector comparison at the end of SPS-1 and at the same time fitted the entry conditions within reasonable bounds.

Further investigation of the evolution of S-IVB IU data processing showed that the "Edited S-IVB IU TM" trajectory presented a much more realistic measurement of the boost trajectory than did the OMPT, and it was decided that the edited IU TM trajectory was the most feasible BET, and the same analysis was repeated with greater success. The results of this analysis are depicted in Table 3-1. The total position and velocity differences between the corrected Apollo IMU and the edited S-IVB/IU are given in Figures 3-2 through 3-7. A detailed discussion of the IMU evaluation may be found in the E&D-38 final report for Apollo 6 (NAS 9-4801).

3.2.2 SPS-1 Burn Reconstruction

The trajectory reconstruction from Apollo IMU data which included SPS-1 was initialized on a state vector from the final OMPT at t=11599.85 seconds (GRR). This is approximately 15 seconds prior to the attempt at S-IVB restart. The reconstruction extends to t = 12218.0 seconds (GRR) which is about 10 seconds after SPS-1 shutdown. This trajectory is corrected for the IMU errors in Table 3-1, and a state vector comparison with the Segment 1 orbital BET (see Section 3.3.1) is given in Table 3-2.

The differences between the two determinations represent errors from three independent areas: (1) the initial state vector from the OMPT, (2) the orbital BET determination, (3) the determination of the IMU errors. These residuals are somewhat smaller than those obtained after the S-IVB second burn on the AS-501 mission because of the improved tracking situations.

Table 3-1. Apollo 6 IMU Errors

Error Source		Derived Error Magnitude	
Velocity Offset	VOX	-4.66	ft/sec
	VOY	-0.66	
	VOZ	0.15	
PIPA Bias	BX	-194	μg
	BY	500	
	BZ	173	
PIPA Scale Factor	XSF	-129.0	PPM
	YSF	-0.5	
	ZSF	-73.1	
PIPA Misalignments	XYMSL	43.3	arc sec
	XZMSL	-55.1	
	YXMSL	57.7	
	YZMSL	21.6	
	ZXMSL	42.1	
	ZYMSL	3.9	
Gyro Bias	XGCDR	0.0185	deg/hr
	YGCDR	-0.0245	
	ZGCDR	-0.0140	
Acceleration Dependent Gyro Drift	XADIA	0.0365	deg/hr·g
	YADIA	-0.0297	
	ZADIA	0.0812	
	XADSR	-0.0086	
	YADSR	-0.0181	
	ZADSR	0.0056	
	XADOA	0.0392	
	YADOA	0.0098	
	ZADOA	0.0186	
Platform Misalignment	PHIX	-0.1	arc sec
	PHIY	9.4	
	PHIZ	0.5	

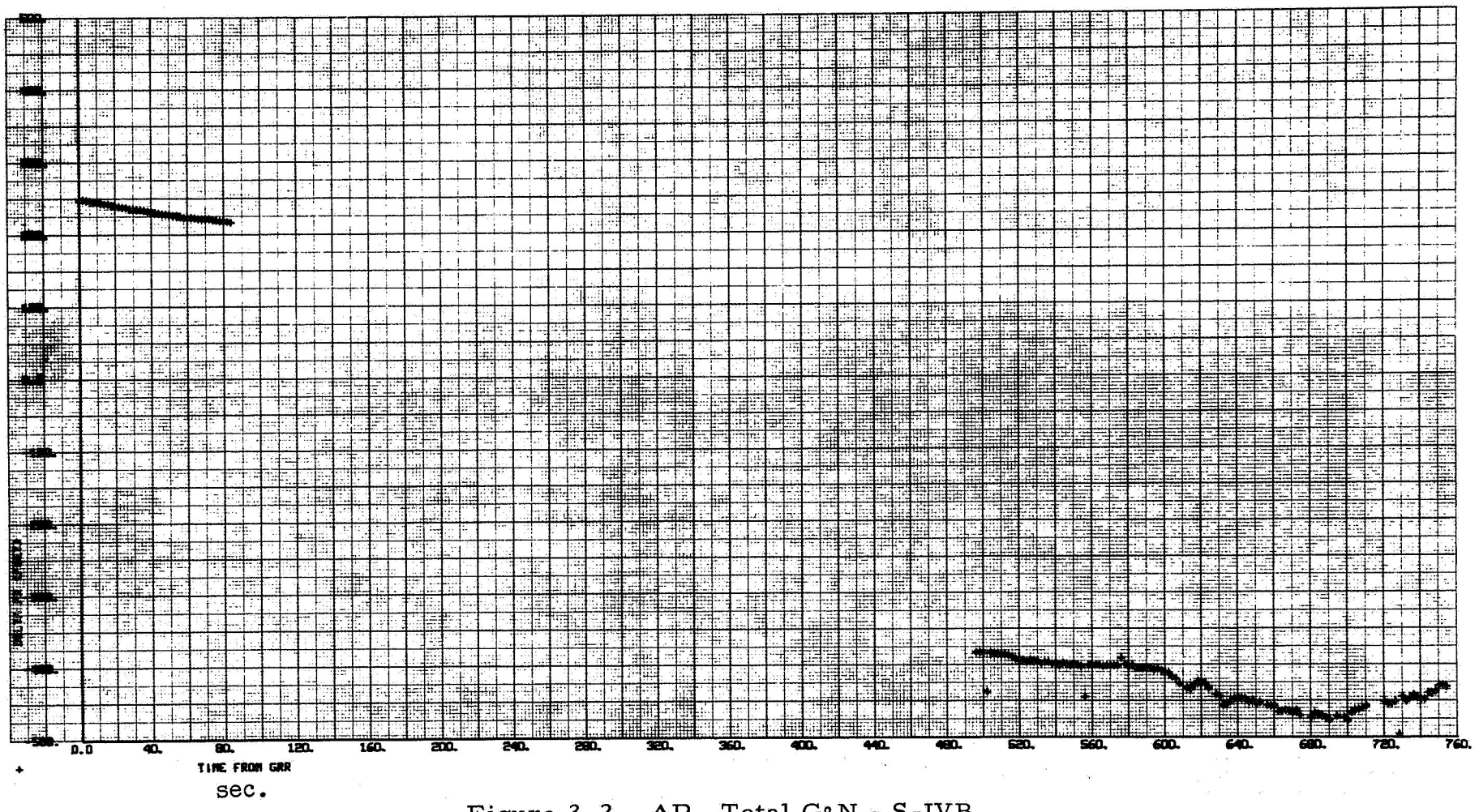

Figure 3-2. ΔP_X Total G&N - S-IVB

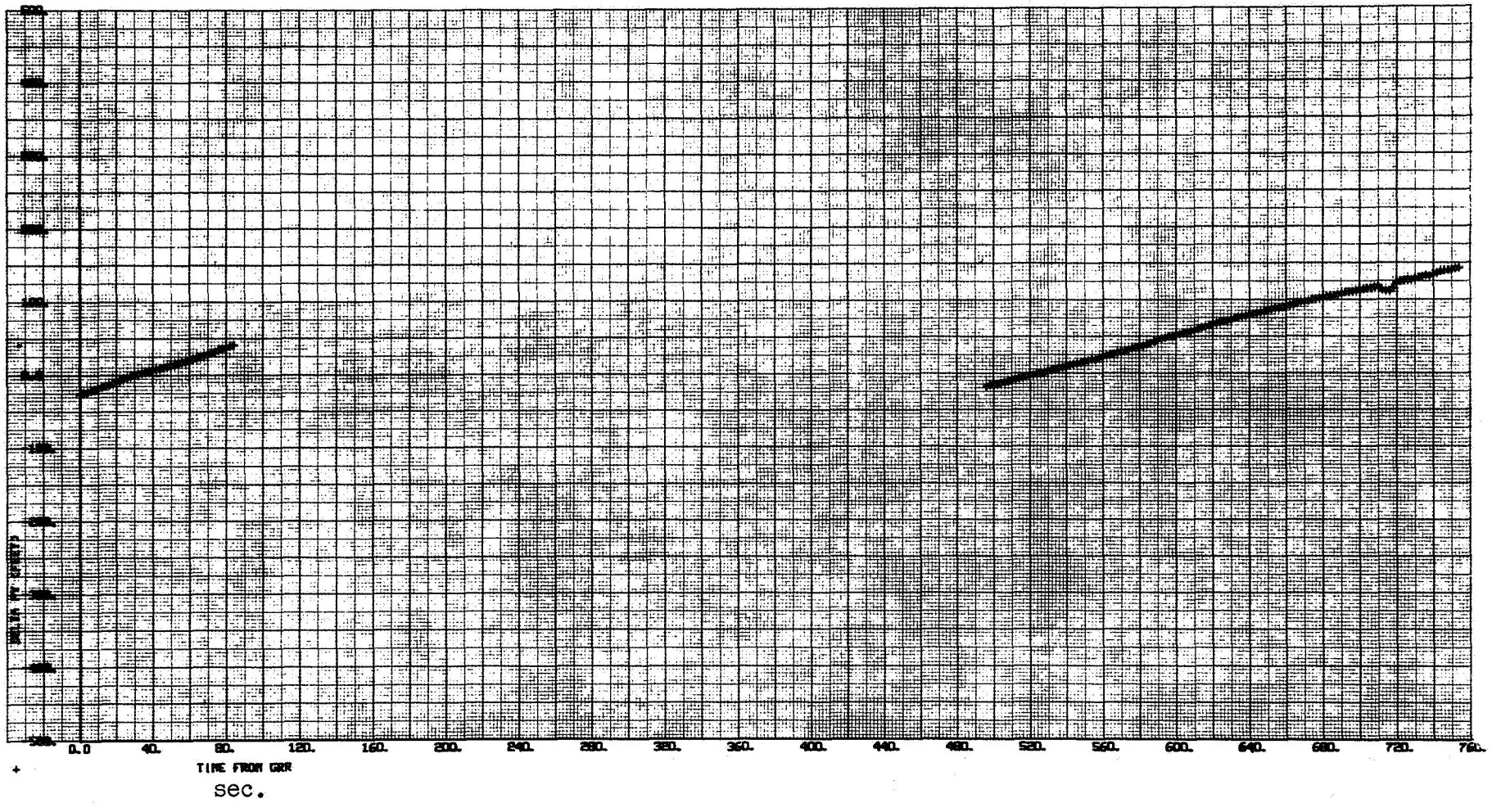

Figure 3-3. ΔP_Y Total G&N - S-IVB

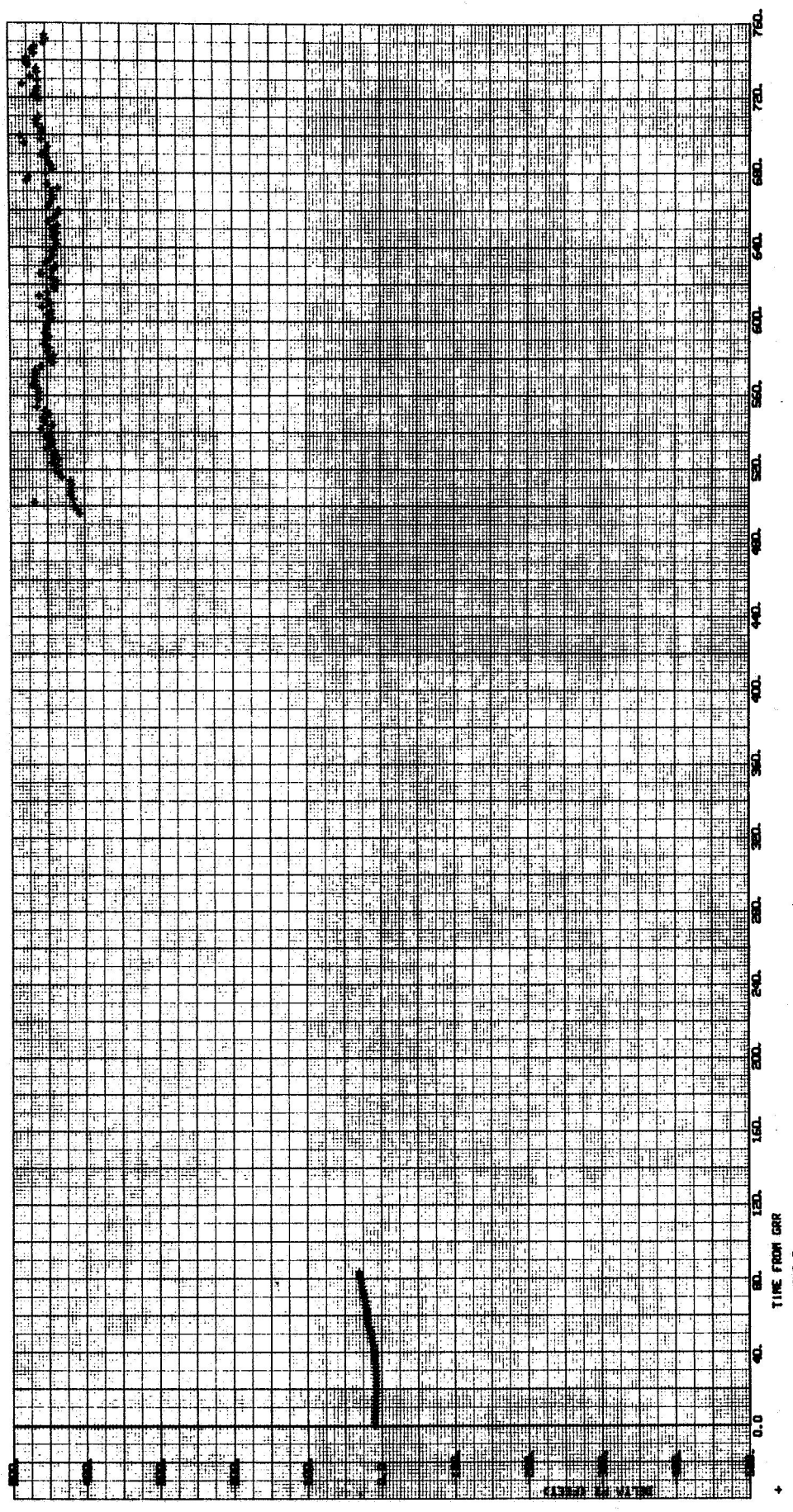

Figure 3-4. ΔP_Z Total G&N - S-IVB

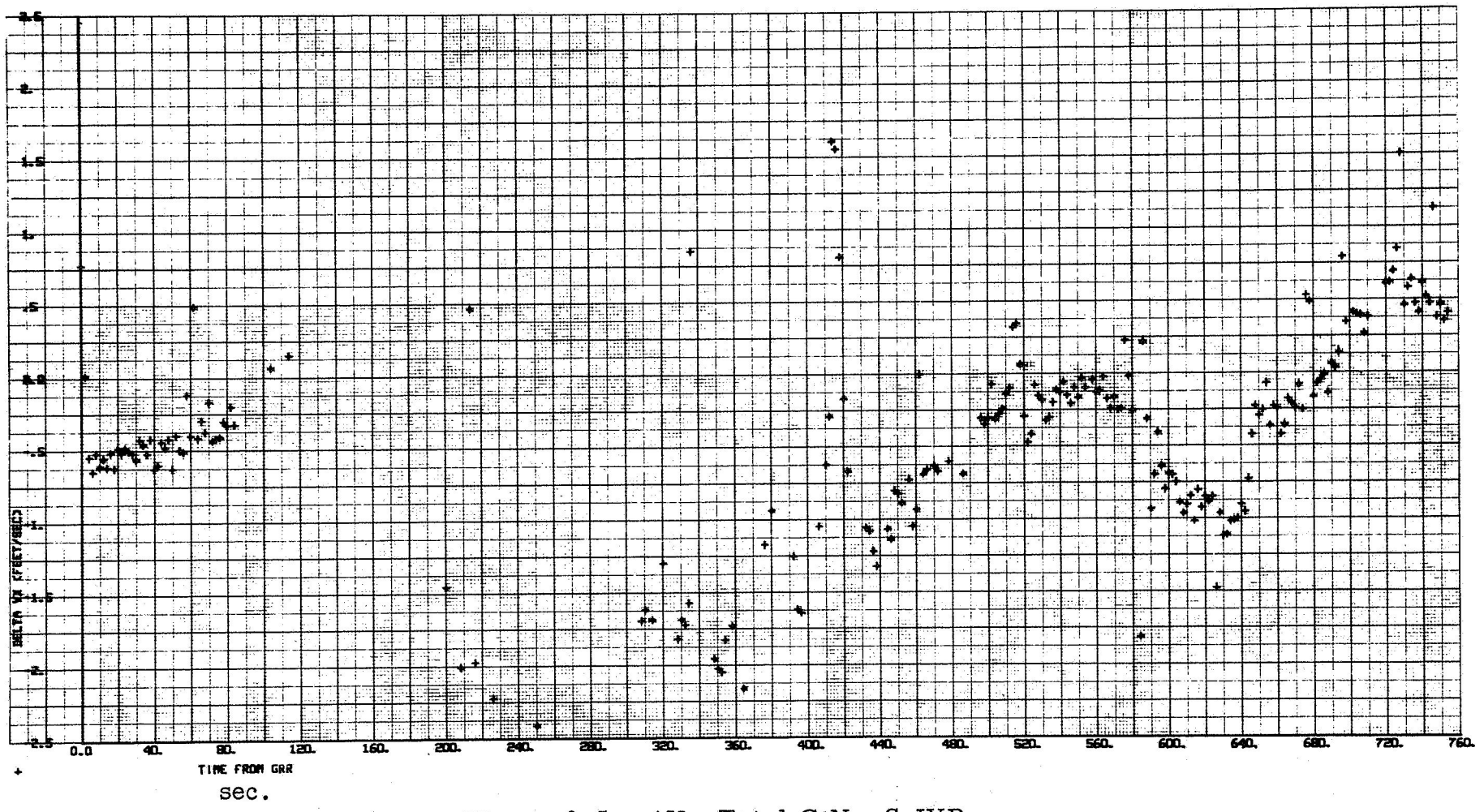

Figure 3-5. ΔV_X Total G&N - S-IVB

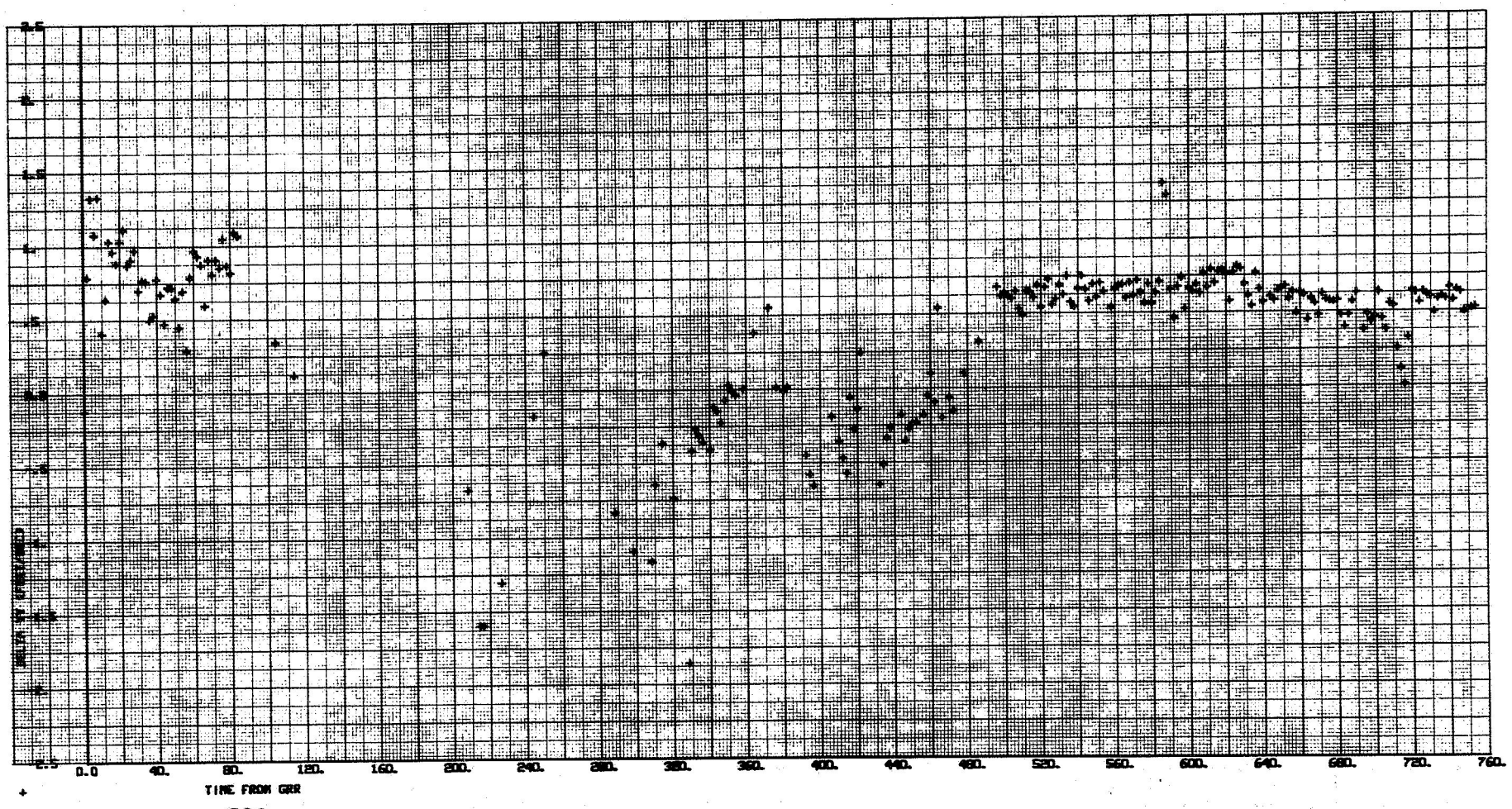

Figure 3-6. ΔV_Y Total G&N - S-IVB

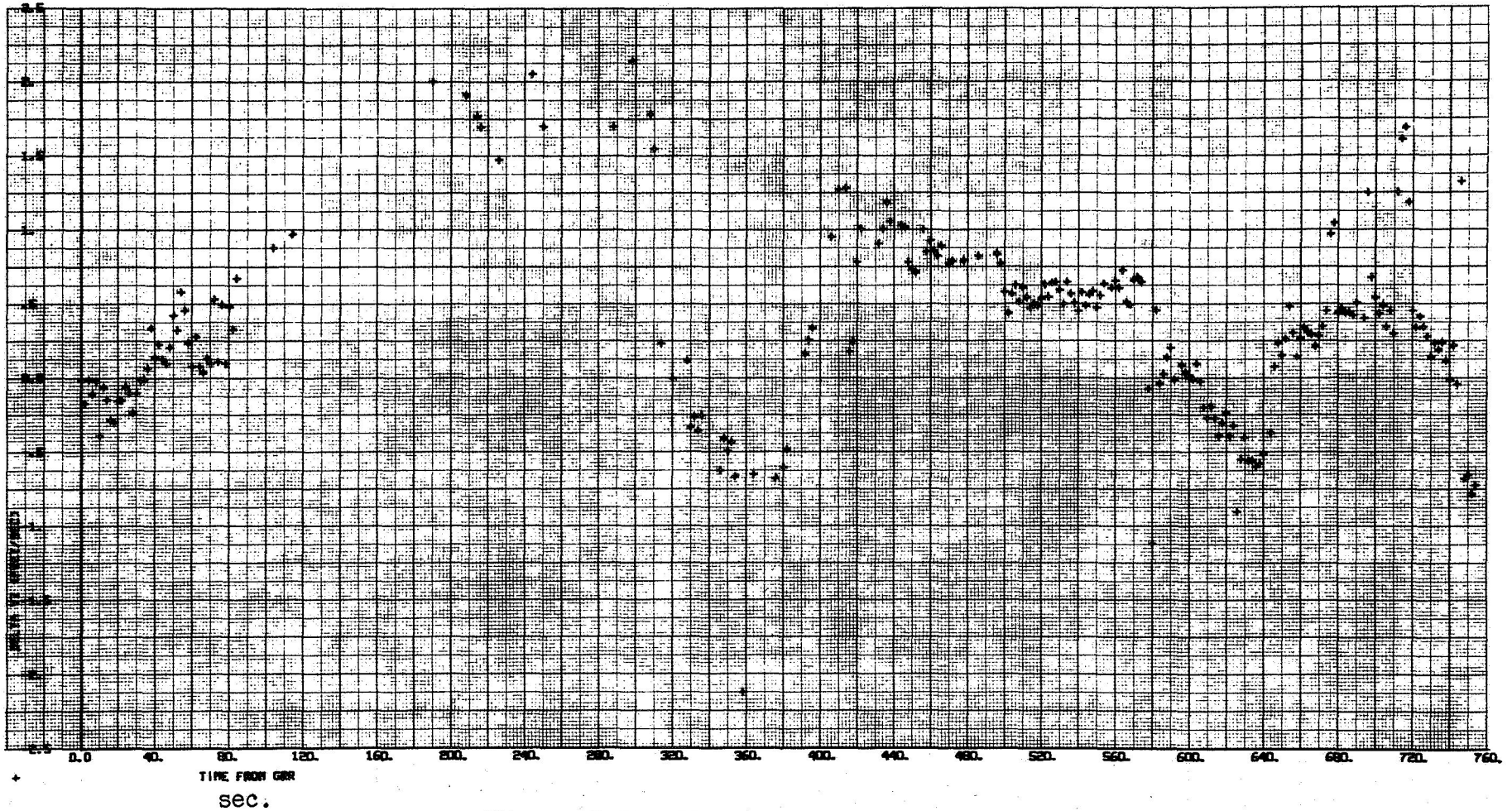

Figure 3-7. ΔV_Z Total G&N - S-IVB

Table 3-2. SPS-1 Endpoint Conditions (t=12218.0 seconds from GRR) APOLLO G&N Platform Coordinates

	IMU Reconstruction	Orbital BET	Δ	Δ(RSS)
X	4,457,484.0 ft	4,456,508.0 ft	976.0 ft	
Y	536,935.0	534,431.0	2,504.0	3,697 ft
Z	22,248,293.0	22,245,754.0	2,539.0	
V_x	-28,561.88 ft/sec	-28,563.62 ft/sec	1.74 ft/sec	
V_y	212.31	218.38	-6.07	6.64 ft/sec
V_z	13,417.89	13,419.95	-2.06	

3.3 ORBIT ANALYSIS

3.3.1 Command Service Module Orbital Reconstruction (Coast Phase)

The command service module trajectory was reconstructed using low speed C-band and low speed S-band radar tracking data and the TRW Orbit Determination Program (ESPOD). For the purpose of reconstructing a best estimate of the trajectory, the CSM orbital phase of the flight was divided into three segments as follows:

a) Segment 1: SPS1 engine cutoff to 19 hours and 00 minutes GMT (6:59:59 GET)

b) Segment 2: 19 hours and 00 minutes GMT (6:59:59: GET) to 21 hours and 10 minutes GMT (9:09:59 GET)

c) Segment 3: 21 hours and 10 minutes GMT (9:09:59 GET) to entry interface (400, 000 feet)

Table 3-3 presents a summary of information pertinent to the reconstruction of each of the above mentioned segments.

Before the reconstruction of each segment is discussed in detail, a few assumptions concerning these fits should be stated. First, it is assumed that all stations are in perfect time synchronization with one another unless otherwise noted. Second, it is assumed that all data are time tagged on the receive pulse; thus, the light time correction retards the time tag of the data. Third, it is assumed that a -0.028 second timing

Table 3-3. CSM Orbital Fit Summary (Coast Phase)

BET	Date	Observation Span GMT (hr:min)	Station/Pass, (Burn)	Drag (ft^2/slug)	Solution Vector
1	4 April	15:24-18:29	ANTCO3, ASCCO3, and CROCO3.	0.1614	State Vector
2	4 April	18:00-21:33	ASCCO3, CROCO3, CROSO3*, GWMSO3*, and (SPS2 ullage).	0.1614	State Vector
3	4 April	20:42-21:33	CROSO3*, GWMSO3*, and (SPS2 ullage).	0.1614	State Vector

*The S-band RXY data was converted to equivalent RAE data and used in the E version of ESPOD.

bias added to all tracking data accounts for the difference between UT 1 (true universal time) and UTC (universal time coordinated) for 4 April 1968.

Information which is too detailed to present in the body of this report, but nevertheless has a significant influence on the resulting BET, is presented in Appendix B. The information found in Appendix B is listed below.

a) A summary of radar observations for the command service module from CSM/S-IVB separation to entry

b) A summary of the station locations used in ESPOD

c) A summary of drag parameter ($C_dA/2m$) values for various phases of the mission

d) A table of radar data weights used in ESPOD for C-band and S-band radar data

The coast phase of the flight lasted for a period of more than six hours. Attempts were made to fit the data from SPS1 engine cutoff to the initiation of SPS2 ullage using various combinations of C-band and S-band low-speed tracking data. However, these fits were not successful.

It was suggested that unmodeled thrusting due to water boiler vent or imperfectly coupled RCS thrusting was the reason for the difficulty in fitting the coast phase in one segment. Attempts were made to model the water boiler vent utilizing the LOP burn model without success (Appendix C contains a discussion of the LOP burn model). This failure resulted in the decision to represent the coast phase of the flight by three fit segments.

The trajectory for Segment 1 was reconstructed from SPS1 engine cutoff to 18 hours and 30 minutes GMT using low-speed C-band tracking data. The quality of the resulting fit which solved on the state vector was good. It should be mentioned that the C-band beacon was turned off at 18 hours, 29 minutes, and 30 seconds GMT, because it was the suspected cause of the attitude control system instability. Although it was later determined that it was not affecting the attitude control system, a decision was made to leave it off for the remaining portion of the flight.

Table 3-4. Residual Mean and RMS by Station and Data Type for Segments 1, 2, 3

Station	Range (ft)			Azimuth* (deg)			Elevation* (deg)			
	Segment 1	Segment 2	Segment 3	Segment 1	Segment 2	Segment 3	Segment 1	Segment 2	Segment 3	
ANTC	10.0			0.0087			-0.0096			Mean
	47.0			0.0047			0.0096			RMS
	3.0			3.0			3.0			N
ASCC	-2.0	22.0		-0.0057	-0.0045		0.0025	0.0012		Mean
	28.0	77.0		0.0048	0.0039		0.0064	0.0053		RMS
	102.0	29.0		103.0	29.0		103.0	29.0		
CROC	-2.0	-187 0		0.0117	0.0121		0.0022	0.0003		Mean
	15.0	141.0		0.0101	0.0120		0.0131	0.0067		RMS
	77.0	24.0		78.0	24.0		78.0	24.0		N
CROS		86.0	1.0		0.0212	0.0028		-0.0439	-0.0458	Mean
		202.0	21.0		0.0238	0.0272		0.0103	0.0125	RMS
		161.0	31.0		237.0	108.0		237.0	108.0	N
GWMS		-16.0	0.0		-0.0752	-0.0723		-0.0109	-0.0243	Mean
		240.0	17.0		0.0066	0.0047		0.0272	0.0189	RMS
		131.0	131.0		132.0	132.0		132.0	132.0	N

*The S-band RXY data were converted to equivalent RAE data and used in the E version of ESPOD.

The residual mean and RMS by station and data type are listed in Table 3-4 for Segments 1 through 3. All quantities are defined as usual and N is the number of data points for each observation. Data anomalies and biases are discussed in the next section for all the segments.

The S-band data were not used in Segment 1, because it slightly degraded the C-band fit, even though the quality of the S-band data was better on this flight than on the Apollo 4 flight. Some representative vector comparisons between the Segment 1 trajectory and a trajectory resulting from a fit of S-band data over the same time period are listed in Table 3-5 below:

Table 3-5. S-band Trajectory Vector Comparisons for the Apollo 6 Mission

Comparison Time (hr:min:sec)	ΔR (ft)	ΔV (fps)
15:23:00	1854.0	1.84
15:53:00	2454.0	0.41
16:23:00	1351.0	0.76
16:53:00	218.0	0.82
17:23:00	1591.0	0.78
17:53:00	2919.0	0.70
18:23:00	4077.0	0.59
18:28:58.5 (Apogee)	4372.0	0.56

The average difference is 2,354 feet in total position and 0.81 foot/second in total velocity for the Apollo 6 mission. The average differences for the Apollo 4 mission for the same portion of the flight were 9,729 feet and 2.29 feet per second in total position and velocity respectively.

The trajectory for Segment 2 represents the portion of the flight that was most difficult to reconstruct. The plot of the orbit plane inclination angle as a function of time as determined by the RTCC (Figure 3-8)

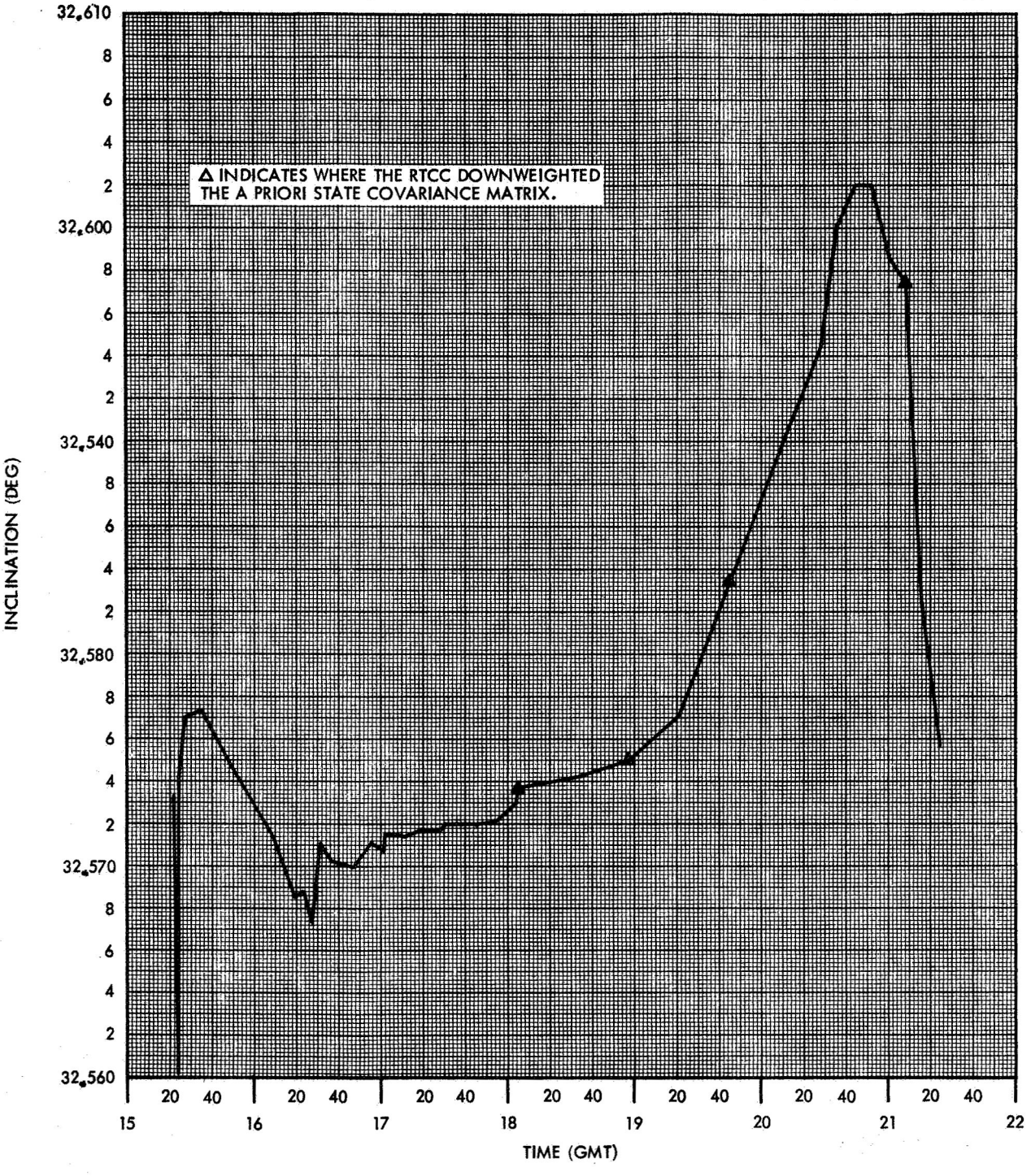

Figure 3-8. Orbit Plane Inclination (from RTCC)

indicates that apparently the unmodeled forces acting on the spacecraft had the most pronounced effect on the trajectory between 19 hours and 0.0 minutes GMT to 21 hours and 20 minutes GMT. Also, it should be noted that the RTCC had to downweight the a priori covariance matrix of the state variables three times during this period. However, since the Carnarvon S-band data are the only data available during this troublesome period, data anomalies could be clouding the issue.

In order to determine the BET, other data must be incorporated into the fit in order to avoid a single station CROS fit. It was decided that the fit that was most consistent with the Segment 1 and Segment 3 trajectories would be chosen as the BET for Segment 2. The fit that was chosen utilized C-band data and S-band RXY data converted to equivalent RAE data and modeled the ullage burn in order to incorporate the post SPS 2 ullage Guam data into the fit. See Table 3-3 for a summary of this fit.

Due to the high quality of the Segment 1 fit , the decision was reached to propagate the BET 1 beyond the fit span to 19 hours and 00 minutes GMT. The Segment 1 and Segment 2 trajectories were compared at this time. The total differences in position and velocity are 4,043 feet and 0.91 feet per second, respectively. The residual mean and RMS by station and data type for Segment 2 are found in Table 3-4.

The Segment 3 trajectory was reconstructed using Carnarvon and Guam RXY tracking data which were converted to equivalent RAE data for use in the E version of ESPOD. The ullage burn was modeled in the fit which solved on the state variables. The data fit reasonably well, although the limited amount of Guam data seemed noisy.

The Segment 2 trajectory and Segment 3 trajectory were compared at 21 hours and 10 minutes GMT. The total differences in position and velocity are 1,709 feet and 3.53 feet per second, respectively. The residual mean and RMS by station and data type are found in Table 3-4.

Table 3-6 lists state vectors corresponding to specific events. The quantities tabulated are defined as follows:

Symbol	Definition of Symbols
LAT	Geodetic latitude of the vehicle measured positive north of the equator (deg)
LON	Longitude of the vehicle measured positive east of the Greenwich meridian (deg)
BETA	Flight-path angle measured positive downward from the local vertical (deg)
AZ	Azimuth of the velocity vector measured positive east of true north (deg)
R	Magnitude of the position vector (ft)
V	Magnitude of the velocity vector (ft/sec)

3.3.2 Data Anomalies and Biases

The following data anomalies were observed by the RTCC during the coast phase of the Apollo VI flight.

a) Following the SPS1 burn ASCC051 data exhibited extremely large angle residuals, (50 degrees and 24 degrees on the Azimuth and Elevation, respectively. The site later reported they had been tracking a side lobe. The data had to be rejected.

b) At 3 hours, 50 minutes, and 00 seconds GET ACNS was asked to reacquire range to obtain an independent range at high elevation.

c) At about 3 hours, 53 minutes GET radar track of the CSM was lost. Only intermittent data were received in Houston. This situation lasted for approximately 18 minutes. Another acquisition message was forced to ACNS and ASCC, and shortly thereafter radar lock was reestablished.

During this period some data were received from ACNS labeled destruct mode.

Table 3-6. State Vector Summary (BET)

Event	Time GET (hr:min:sec)	LAT (deg)	LON (deg)	BETA (deg)	AZ (deg)	R (ft)	V (ft/sec)
SPS-1 Engine Cutoff	3:23:27.90	20.40638	31.52397	76.48669	116.06003	22,609,987.0	31,632.756
Apogee	6:28:57.05	-31.52923	51.53709	89.99386	80.67862	93,938,956.0	7,402.750
SPS-2 Ullage On	9:29:19.10	23.83938	122.18518	111.44379	66.98074	25,472,509.0	29,335.472
SPS-2 Ullage Off	9:30:09.20	25.04101	125.16530	110.33532	68.29248	24,944,629.0	29,751.451
CM/SM Separation	9:36:56.60	32.37442	157.32851	98.89687	84.90484	21,688,900.0	32,472.476
Entry	9:38:27.97	32.73260	166.28561	95.85270	89.92080	21,305,463.0	32,830.048

d) At approximately 5 hours 30 minutes GET, CRO was asked to hold the C-band data and send their S-band data to Houston. This was done to gain information for one more independent system prior to the AGC NAV update.

e) At 6 hours 29 minutes 30 seconds GET the C-band beacon was turned off aboard the CSM. It was hoped that this would clear up a BMAG problem. It did not; however, the beacon was not turned back on in an effort to conserve power. Hence, during the latter part of the coast ellipse, only CROS data were received.

In addition, the ASCC03 data were bad from 17 hours, 25 minutes, and 54 seconds GMT to 17 hours, 43 minutes, and 12 seconds GMT. A similar problem was observed on Apollo 4 flight; the problem has been traced to a timing error in the range computer.

The following apparent data biases were observed from Table 3-4 and from single station fits of the data.

ACNS	A Y-angle bias of 0.023 degree was observed on a single station fit of ACNS03 data.
CROS	A Y-angle bias of 0.076 degree was observed on a single station fit of CROS03 data.
ASCC	An average azimuth bias of -0.0054 degree was observed from Table 3-4.
CROC	An average azimuth bias of 0.0118 degree was observed from Table 3-4.

3.3.3 Maneuver Analysis

It was not possible to reconstruct the SPS 1 burn accurately in the ESPOD program using low-speed C-band tracking data and telemetered acceleration information in the form of an acceleration burn tape. However, the SPS 2 ullage burn was modeled in the Segment 3 trajectory. In order to give the reader some idea of the magnitudes of these burns, the following information is tabulated in Table 3-7:

a) The maneuver

b) The time of initiation of the maneuver (GET)

c) The source of the information

d) The duration of the maneuver in seconds (Δt)

e) The component ΔV's in Apollo guidance platform coordinates (ΔV_x, ΔV_y, ΔV_z)

f) The velocity increment (ΔV)

The listed velocities have not been corrected for guidance errors.

3.3.4 S-band Radar Data Weighting

During the period of time that Carnarvon S-band data were available for use by the RTCC, it was necessary to downweight the a priori covariance matrix of the state variables four times (ASCC 80: 18 hours, 07 minutes, and 42 seconds; CROS 83: 18 hours, 57 minutes, and 36 seconds; CROS 85: 19 hours, 45 minutes, and 30 seconds; and CROS 92: 21 hours, 08 minutes, and 12 seconds). Now unmodeled forces, such as water boiler vent and imperfectly coupled RCS thrusting could necessitate the downweighting of the a priori covariance matrix. However, there is another possible explanation for the downweighting of the a priori covariance matrix by the RTCC. If the X, Y angles were biased on the Carnarvon S-band data, and if the angle data were weighted too heavily with respect to the prime observable (doppler), then the incorrest estimate of state based on the biased angles when propagated would lead to an inconsistency between the propagated a priori covariance matrix and later data. This would force the RTCC to downweight the a priori covariance matrix to fit the current data.

Now a single station fit of Carnarvon S-band data using the noise values listed in the Apollo Navigation Working Group (ANWG) document indicated an apparent 0.076-degree bias in the Y-angle. In order to test the hypothesis described above, fits were made using the following three-sigma weighting schemes and assuming that the CROS Y-angle had a 0.076-degree bias:

Table 3-7. Maneuver Summary

	Time of Initiation, GET (hr:min:sec)	Source	Δt (sec)	ΔV_x (ft/sec)	ΔV_y (ft/sec)	ΔV_z (ft/sec)	ΔV (ft/sec)
SPS-2 Ullage	9:29:19.1	G&N	50.1	-13.142	-1.142	17.269	21.731
SPS-1	3:16:06.2	G&N	441.7	-3967.92	122.82	6758.17	7837.87

	Range (ft)	X, Y-Angle (m rad)	Doppler (cps)
Data Weighting Set 1:	90.0	2.4	0.2
Data Weighting Set 2:	900.0	1.8	1.8
Data Weighting Set 3:	weighted out	2.4	1.2
Data Weighting Set 4:	weighted out	2.4	0.2

where set 1 is the set of weights used by A-50 and is based on ANWG, set 2 is the set of weights used by the RTCC for the Apollo 6 mission, set 3 is the set of weights suggested for the Apollo C mission except that range is weighted out, and set 4 is a set of weights generated for purpose of this discussion.

The fit using set 1 will be the standard of comparison. Table 3-8 lists the resulting data mean and RMS for the four fits while Table 3-9 lists the differences in the resulting state vectors at 21 hours and 10 minutes GMT. For Table 3-9 the run, which used weighting set 1, will be called fit 1, and etc.

Table 3-8. Data Mean and RMS

Weighting Set	Range (ft)	X-Angle (deg)	Y-Angle (deg)	Doppler (cps)	
1	16.0	-0.0078	-0.0764	-0.0231	Mean
	23.0	0.0129	0.0093	0.0974	RMS
2	49.0	-0.0016	0.0317	0.0127	Mean
	39.0	0.0285	0.0080	0.1985	RMS
3	-2389.0	0.0024	0.0142	-0.0236	Mean
	53.0	0.0181	0.0087	0.2964	RMS
4	2576.0	-0.0241	0.0694	0.0013	Mean
	36.0	0.0260	0.0081	0.0916	RMS

Table 3-9. Total Position and Velocity Differences (21:10:00 GMT)

Fits Differenced	ΔR (ft)	ΔV (fps)
Fit 2 - Fit 1	17,381.0	15.63
Fit 3 - Fit 1	21,065.0	27.00
Fit 4 - Fit 1	8,083.0	5.94

It can be seen in Table 3-8 that fit 2 has degraded the fit of the range, X-angle, and doppler data. Table 3-9 indicates that such a weighting scheme (set 2) will produce a significant error in the trajectory. These results substantiate the hypothesis described above.

Fit 3 indicates that the third weighting scheme (set 3) is not strong enough to overcome the effect of the bad angles, while fit 4 shows significant improvement in both residual means and biases and trajectory differences over fits 2 and 3.

A number of conclusions can be drawn. First, since the S-band angular data bias uncertainties are at least four times larger than the corresponding C-band angular data bias uncertainties, the doppler data which is the prime observable should be weighted so that it can overcome the effect of these angles which have a high probability of being bad. Second, the range data should be included in the fit but not to such an extent that it overrides the doppler data. Third, the S-band weighting scheme will be important on the C mission where the only C-band data available for the spacecraft will be skin track data.

3.4 RTCC TRAJECTORY COMPARISON

The state vectors obtained in real time by the RTCC for the Apollo 6 mission were compared with the Task A-50 best estimate of the trajectory at RTCC anchor times from CSM/S-IVB separation to entry interface. The purpose of making these comparisons is to aid the RTCC in evaluating fit procedures for this and subsequent Apollo missions.

The state vector comparisons are discussed in this section. Also included in the discussion is a set of special state vector comparisons of prime interest to the RTCC. As previously noted, a time bias was added to the time tag of the low-speed tracking data to account for the difference between UT1 and UTC. The real-time orbit determination program does not account for the difference between UT1 and UTC. However, when the comparisons were made, the BET was adjusted so that the BET and the RTCC trajectory were using the same time scale (UTC).

Table 3-10 lists in detail the data received and processed by the RTCC. The maximum elevation of the pass (E_{max}), the anchor vector time (GMT), the number of valid points in each batch (No), and an indication that the data were either accepted or rejected (A/R) is tabulated. An "S" in the accept/reject column denotes a single station solution, while an N indicates the data that were not processed. The batch number is simply a numbering system used by the RTCC and has no special significance. The MSC memorandum on the RTCC Mission Data Summary was the source of Table 3-10.

RTCC Comparisons

A summary of comparisons is listed in Table 3-11. The table lists the data used in the fit to obtain the RTCC vector, the RTCC batch number, the RTCC anchor time (GMT), the maximum elevation of the pass (E_{max}), the BET segment number, the total difference in position (ΔR), and the total difference in velocity (ΔV).

During the first 4 1/2 hours of the coast ellipse (SPS-1 engine cutoff to 20 hours GMT) the RTCC vector comparisons were better on the Apollo 6 flight than for a similiar period of the Apollo 4 flight. On Apollo 4, data from Carnarvon were not available until just prior to apogee. Therefore, the RTCC vectors which were based on Ascension C-band and S-band data were essentially a result of single station fits. However, on Apollo 6 Carnarvon C-band and S-band data and Pretoria C-band data were available to the RTCC much earlier. Consequently, the RTCC could alternate ACNS, CROC, PREC, ASCC, and CROS data in the fits. This procedure results in much better geometry and is reflected in the better comparisons.

Table 3-10. Summary of Radar Data for Apollo 6 (Coast Phase)

Code	Batch	Anchor Time (hr:min:sec)	No.	E_{MAX} (deg)	A/R
ANTC	62	15:23:30	28	7	S
REDC	63	15:23:30	80	66	R
ACNS	49	15:27:36	80	66	A
ASCC	51	15:34:54	18	69	R
ACNS	52	15:35:48	80	67	A
ASCC	55	15:48:24	26	45	A
ASCC	57	16:09:06	43	30	A
ACNS	58	16:19:36	80	26	A
ASCC	59	16:24:42	80	24	A
ACNS	60	16:27:36	80	24	A
CROC	61	16:31:48	80	11	A
PREC	64	16:37:36	80	78	A
ASCC	65	16:38:30	80	21	A
ACNS	66	16:47:24	80	20	A
CROC	67	16:55:36	80	17	A
PREC	68	17:01:30	51	72	A
ASCC	69	17:02:42	80	18	A
ACNS	70	17:11:12	63	17	A
CROC	71	17:19:24	26	18	A
PREC	73	17:28:48	67	68	A
CROS	74	17:30:42	80	21	A
ASCC	75	17:36:30	23	15	A
ASCC	76	17:45:36	74	14	A
CROS	77	17:54:30	38	22	A
PREC	78	18:04:24	80	65	A
CROS	99	18:05:24	80	24	N
CROC	79	18:06:12	78	24	A
ASCC	80	18:07:42	72	13	A
CROS	100	18:13:24	80	24	N
CROS	101	18:21:24	80	24	N

Table 3-10. Summary of Radar Data for Apollo 6 (Coast Phase) (Continued)

Code	Batch	Anchor Time (hr:min:sec)	No.	E_{MAX} (deg)	A/R
CROS	102	18:29:24	10	24	N
CROS	82	18:33:48	80	25	A
CROS	83	18:57:36	80	25	A
CROS	84	19:21:36	80	26	A
CROS	85	19:45:30	80	27	A
CROS	86	20:09:30	80	27	A
CROS	87	20:28:06	80	27	A
CROS	88	20:36:12	80	28	A
CROS	89	20:44:12	80	28	A
CROS	90	20:52:12	80	27	A
CROS	91	21:00:12	80	27	A
CROS	92	21:08:12	59	24	A
GWMS	93	21:16:54	80	9	A
GWMS	95	21:24:54	51	13	A
GWMS	97	21:30:00	16	14	S
GWMS	98	21:31:36	13	14	A
GWMS	96	21:32:54	15	12	A
WTNS	103	21:36:02	10	50	A

Table 3-11. RTCC Comparison Summary

Station	Batch	Anchor Time (hr:min:sec)	E_{max} (deg)	BET	ΔR (ft)	ΔV (ft/sec)
ANRC	62	15:23:30	7	1	1,665	4.23
ACNS	49	15:27:36	66	1	879	4.61
ACNS	52	15:35:48	67	1	1,999	5.34
ASCC	55	15:48:24	45	1	4,776	4.11
ASCC	57	15:09:06	30	1	7,784	2.77
ACNS	58	16:19:36	26	1	12,015	2.88
ASCC	59	16:24:42	24	1	11,902	2.46
ACNS	60	16:27:36	24	1	14,194	2.70
CROC	61	16:31:48	11	1	9,405	1.46
PREC	64	16:37:36	78	1	11,281	1.23
ASCC	65	16:38:30	21	1	11,398	1.22
ACNS	66	16:47:24	20	1	11,983	0.96
CROC	67	16:55:36	17	1	10,647	0.55
PREC	68	17:01:30	72	1	11,256	0.39
ASCC	69	17:02:42	18	1	10,739	0.12
ACNS	70	17:11:12	17	1	10,710	0.20
CROC	71	17:19:24	18	1	10,015	0.34
PREC	73	17:28:48	68	1	9,800	0.51
CROS	74	17:30:42	21	1	9,350	0.57
ASCC	75	17:36:30	15	1	9,012	0.67
ASCC	76	17:45:36	14	1	8,766	0.73
CROS	77	17:54:30	22	1	8,114	0.83
PREC	78	18:04:24	65	1	6,150	1.04
CROC	79	18:06:12	24	1	4,901	1.07
ASCC	80	18:07:42	13	1	4,683	1.06
CROS	82	18:33:48	25	1	3,041	1.08
CROS	83	18:57:36	25	1	2,190	1.00
CROS	84	19:21:36	26	2	2,624	0.99
CROS	85	19:45:30	27	2	3,018	1.03
CROS	86	20:09:30	27	2	4,430	2.14

Table 3-11. RTCC Comparison Summary (Continued)

Station	Batch	Anchor Time (hr:min:sec)	E_{max} (deg)	BET	ΔR (ft)	ΔV (ft/sec)
CROS	87	20:28:06	27	2	7,442	2.75
CROS	88	20:36:12	28	2	14,768	3.54
CROS	89	20:44:12	28	2	18,835	3.42
CROS	90	20:52:12	27	2	19,409	2.84
CROS	91	21:00:12	27	2	13,593	2.21
CROS	92	21:08:12	24	2	7,795	2.14
GWMS	93	21:16:54	9	3	1,987	4.10
GWMS	95	21:24:54	13	3	1,051	4.01
GWMS	97	21:30:00	14	3	13,781	36.16
GWMS	98	21:31:36	14	3	11,986	36.55
GWMS	96	21:32:54	12	3	11,663	35.30

During the last 1 1/2 hours of the coast ellipse, 20 hours GMT to entry, the RTCC vector comparisons were worse on the Apollo 6 flight then on the Apollo 4 flight. There are a number of possible reasons for this situation. These reasons are listed as follows:

- Unmodeled forces such as water boiler vent and imperfectly coupled RCS thrusting had a more significant effect on the trajectory during this period of the flight.
- The only data available were CROS data which resulted in single station fits.
- An RTCC data weighting scheme which weighted the biased Y-angle data too heavily would affect the resultant estimate of the trajectory. This situation has been discussed in the previous section.

The summary of special comparisons can be found in Table 3-12. The vectors are time ordered according to anchor time and the total difference in position and velocity is listed.

Table 3-12. RTCC Comparison Summary for Special Vectors

Vector Description	Anchor Time (hr:min:sec)	ΔR (ft)	ΔV (ft/sec)
High-speed Telemetry Vector	15:23:40.15	24,564	37.02
High-speed Radar Cutoff Vector Following SPS-1	15:24:49.4	5,926	16.27
AGC Navigation Update Prior to Entry	17:45:36	8,766	0.73

The vector used to build the AGC navigation update prior to SPS-2 was much better on the Apollo 6 mission than on the Apollo 4 mission, cf 8,766 feet versus 15,219 feet in position and 0.73 feet per second versus 5.57 feet per second in velocity. This again is the result of data from stations other than Ascension being available to the RTCC.

A suggested improvement in the RTCC fit procedure is described as follows:

Since the RTCC is limited in the number of data points that can be batched at one time, it is suggested that during a coast ellipse or trans-lunar trajectory the data rate be decreased, i. e. from one observation per 0. 1 minute to one observation per minute. This will increase the data arc represented by a batch of data.

The output of the RTCC Comparison Program is found in Appendix A.

3. 5 ENTRY TRAJECTORY RECONSTRUCTION

The set of IMU errors given in Table 3-1 was used to reconstruct the entry trajectory from t = 34, 621. 41 seconds (GRR) to splashdown using telemetry data from the AGC. The trajectory was initialized on a state vector from the segment 3 orbital BET (Section 3. 1. 1).

Information concerning the actual entry trajectory is available from several sources. The actual impact point was estimated from optical sightings. The final estimates are as follows:

a) N Latitude = 27° 40' = 27.6687°

b) E Longitude = 202° 01' = -157.9833°

The times of drogue and main chute deployments were determined from baroswitch closure times reflected in the telemetry data. The altitudes at which these events most probably occurred were determined from baroswitch presettings and measurements of the atmospheric pressure profile.

Experience with the Apollo command module descent rate on the main parachutes leads to an expected vertical velocity of 28 to 30 feet per second.

Comparison of the reconstructed trajectory with these known constraints is given in Table 3-13. It is most convenient to express the constraints in an ESF Cartesian frame with origin at the actual impact point; (the BET tape contains these coordinates with origin at the planned splashpoint, 27.31667° N, -157.18333° E).

Table 3-13. Entry Trajectory Comparison to Known Constraints

Event	Known Constraints	Reconstructed Trajectory
Drogue Deployment t = 35, 486. 25 sec (GRR)	P (up) 23, 600 ft	22, 548 ft
Main Chute Deployment t = 35, 532. 25 sec (GRR)	P (up) 10, 900 ft	9, 805 ft
Splashdown	P (up) 0	51 ft
	Q (south) 0	6, 084
	R (east) 0	22, 688
	$\dot{P}$ (up) -28 to -30 ft/sec	-26. 4 ft/sec (average)

The only significant difference from the known constraints is that the reconstructed impact point is about 3. 8 nautical miles east of the visual sighting.

Figure 3-9 illustrates the altitude - time history of the entry BET from drogue deployment to splashdown.

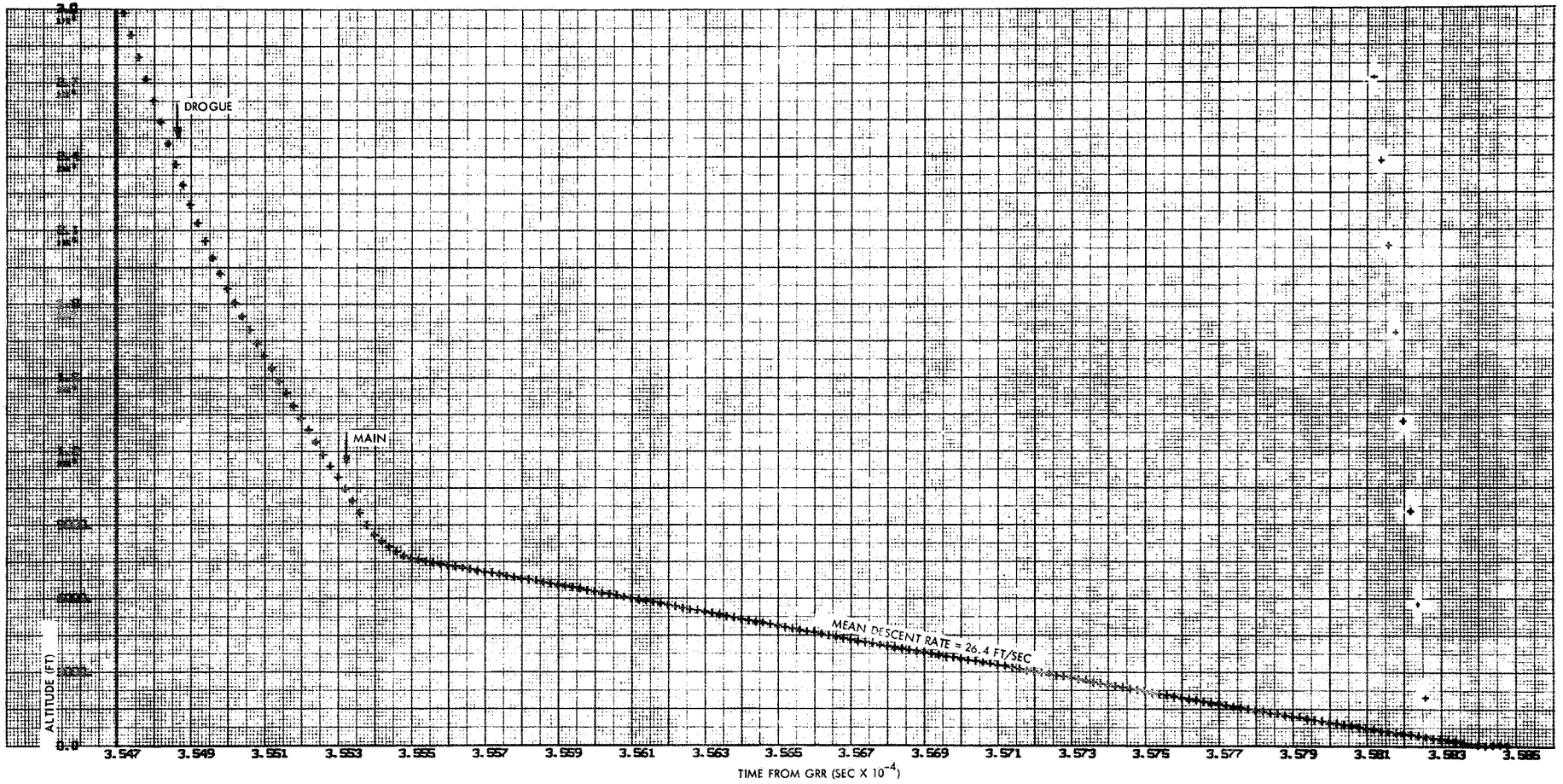

Figure 3-9. Altitude Profile on Parachutes

APPENDIX A

APOLLO 6 RTCC COMPARISONS

The output of the RTCC Comparison Program is listed for each vector appearing in Table 3-11 and Table 3-12. The vector comparisons are listed in the order of occurrence in Table 3-11 and Table 3-12. The definitions of the symbols used are as follows:

Symbol	Definition of Symbols for RTCC Comparison
X, Y, Z, $\dot{X}$, $\dot{Y}$, $\dot{Z}$	Components of the position and velocity vector referenced to a geocentric, inertial, Cartesian, coordinate system. It is a right-handed system where the X-axis lies in the true equatorial plane in the direction of the Greenwich meridian at 0^h day of launch, the Z-axis is orthogonal to the true equatorial plane, and the Y-axis completes the right-handed system. The units are earth radii and earth radii/hour.
SEMIMAJOR	Semimajor axis (ft)
ECCEN	Eccentricity of the orbit
INCL	Inclination of the orbit plane to the equator measured positive counterclockwise from the equatorial plane to the orbit plane at the ascending node (deg)
NODE	Right ascension of the ascending node (deg)
ARG PERIGEE	Argument of perigee measured positive in the direction of motion from the ascending node (deg)
TRUE ANOM	True anomaly measured positive in the direction of motion (deg)
PERIOD	Osculating period of the orbit (min)
APOGEE	Altitude of apogee above a reference sphere (n mi)
PERIGEE	Altitude of perigee above a reference sphere (n mi)

Symbol	Definition of Symbols for RTCC Comparison
VEL-MAG	Magnitude of the inertial velocity vector (ft/sec)
FLT PATH	Flight path angle measured positive downward from the local vertical (deg)
HEADING	Azimuth of the velocity vector measured positive east of true North (deg)
DECLIN	Declination (deg)
LONG	Longitude of the vehicle measured positive east of the Greenwich meridian (deg)
HEIGHT	Height of the vehicle above a reference sphere (n mi)
DELTA U DELTA V DELTA W DELTA UDOT DELTA VDOT DELTA WDOT	Difference between the RTCC and ESPOD-developed components of the position and velocity vector in a vehicle-centered, coordinate system where the U-axis is collinear with the earth-centered inertial radius vector and is directed outward, the V-axis lies in the orbit plane and is orthogonal to the U-axis, and the W-axis completes the right-handed system.
DELTA POS	Magnitude of the difference between the RTCC position vector and the ESPOD-developed position vector.
DELTA VEL	Magnitude of the difference between the RTCC velocity vector and the ESPOD-developed velocity vector

ANTC 062 28 OBS SS MAN,ACC,NO UPD 1EDIT 1ITER VEH 1

TIME U.T.
4/ 4/68 15 HRS 23 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 3 HRS 23 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.10069656E 01	-0.12046175E 00	0.37394097E 00	-0.14212440E 01	-0.49545694E 01	-0.17412135E 01	RTCC
-0.10069169E 01	-0.12046264E 00	0.37400389E 00	-0.14219389E 01	-0.49545939E 01	-0.17414259E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57548662.50	0.63485025	32.57333517	42.07220793	104.83209324	35.18269920	RTCC
57565820.50	0.63498006	32.57992983	42.07105017	104.82539272	35.18892860	TRW
-17158.00	-0.00012981	-0.00659466	0.00115776	0.00670052	-0.00622940	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
385.33059692	12042.79992676	17.09631348		RTCC
385.50293350	12048.64611816	16.89761353		TRW
-0.17233658	-5.84619141	0.19869995		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
31624.2756	76.45928001	116.08219719	20.24020362	315.31469727	281.16894531	RTCC
31625.8560	76.45517063	116.08778095	20.24421740	315.31507874	281.08801270	TRW
-1.58032227	0.00410938	-0.00558376	-0.00401378	-0.00038147	0.08093262	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
492.	571.	-1484.	-3.35	-0.82	2.44

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
1665.	4.23

ACNS 049 80 OBS MS MAN,ACC,NO UPD 1 EDIT 6ITER VEH 1

TIME U.T.
4/ 4/68 15 HRS 27 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 3 HRS 27 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.10692055E 01	-0.45133654E 00	0.24368296E 00	-0.43542800E 00	-0.46901020E 01	-0.20381880E 01	RTCC
-0.10691648E 01	-0.45133859E 00	0.24367265E 00	-0.43578777E 00	-0.46898993E 01	-0.20388642E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57568827.50	0.63491974	32.57715082	42.07011938	104.85807323	52.70655251	RTCC
57569565.50	0.63494474	32.58596277	42.06402636	104.86098099	52.70957851	TRW
-738.00	-0.00002500	-0.00881195	0.00609303	-0.00290775	-0.00302601	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
385.53314209	12048.88378906	17.64978027	RTCC
385.54055023	12049.31921387	17.45718384	TRW
-0.00740814	-0.43542480	0.19259644	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
29832.7500	69.95917606	120.56618595	11.85811758	330.35084534	642.71228027	RTCC
29833.4121	69.95755482	120.57576180	11.85799479	330.35172653	642.58132935	TRW
-0.66210938	0.00162125	-0.00957584	0.00012279	-0.00088120	0.13095093	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
796.	-346.	-143.	-0.63	-0.48	4.54

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
879.	4.61

ACNS 052 80 OBS MS MAN,ACC,NO UPD IEDIT 4 ITER VEH 1

TIME U.T.
4/ 4/68 15 HRS 35 MIN 48.000 SEC

TIME FROM LAUNCH
0 DAYS 3 HRS 35 MIN 47.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.10305329E 01	-0.10341011E 01	-0.49328180E-01	0.85932177E 00	-0.38133359E 01	-0.21767145E 01	RTCC
-0.10305403E 01	-0.10340708E 01	-0.49418454E-01	0.85883003E 00	-0.38130548E 01	-0.21774374E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57535485.50	0.63459855	32.57741404	42.06785202	104.88610363	78.70965672	RTCC
57534790.00	0.63462882	32.58879995	42.06255007	104.88408470	78.71717548	TRW
695.50	-0.00003027	-0.01138592	0.00530195	0.00201893	-0.00751877	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
385.19825745	12036.87097168	18.68786621	RTCC
385.19126892	12036.97070313	18.35940552	TRW
0.00698853	-0.09973145	0.32846069	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
26006.9346	61.03354216	122.52620792	-1.93519090	350.50851440	1589.38931274	RTCC
26007.0376	61.03011227	122.53742790	-1.93875133	350.50746918	1589.34384155	TRW
-0.10302734	0.00342989	-0.01121998	0.00356042	0.00104523	0.04547119	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
277.	-551.	1901.	-1.00	0.44	5.22

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
1999.	5.34

TIME U.T.
4/ 4/68 15 HRS 48 MIN 24.000 SEC

TIME FROM LAUNCH
0 DAYS 3 HRS 48 MIN 23.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.74696470E 00	-0.17012892E 01	-0.48722435E 00	0.16873241E 01	-0.26075187E 01	-0.19590618E 01	RTCC
-0.74704447E 00	-0.17012156E 01	-0.48742511E 00	0.16869270E 01	-0.26073027E 01	-0.19596057E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57500580.50	0.63434697	32.57495832	42.06432581	104.88229179	103.22424793	RTCC
57499356.50	0.63437331	32.58551168	42.06051540	104.87955284	103.23050785	TRW
1224.00	-0.00002635	-0.01055336	0.00381041	0.00273895	-0.00625992	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.84777451	12025.10009766	18.96954346	RTCC
384.83548355	12025.02001953	18.64654541	TRW
0.01229095	0.08007813	0.32299805	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
21344.6924	54.15756655	119.40414047	-14.69349873	8.54660547	3173.99374390	RTCC
21344.4270	54.15479755	119.41328621	-14.69955850	8.54343975	3174.05148315	TRW
0.26538086	0.00276899	-0.00914574	0.00605977	0.00316572	-0.05773926	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-351.	-217.	4758.	-0.59	0.75	4.00

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
4776.	4.11

ASCC 057 43 OBS MS MAN,ACC,NO UPD 1EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 16 HRS 9 MIN 6.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 9 MIN 5.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.95441780E-01	-0.23667389E 01	-0.10817586E 01	0.19805711E 01	-0.13706232E 01	-0.14976506E 01	RTCC
-0.95597509E-01	-0.23666162E 01	-0.10820734E 01	0.19802867E 01	-0.13704894E 01	-0.14980078E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57486587.00	0.63427603	32.57156897	42.05597734	104.87901020	125.62388992	RTCC
57484393.00	0.63429669	32.58120632	42.05389023	104.87518883	125.62897110	TRW
2194.00	-0.00002067	-0.00963736	0.00208712	0.00382137	-0.00508118	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.70729446	12020.66491699	18.79861450	RTCC
384.68527222	12020.27038574	18.47103882	TRW
0.02202225	0.39453125	0.32757568	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
16486.1951	50.72883511	112.11286640	-24.54598856	24.75242472	5526.62493896	RTCC
16485.7615	50.72713280	112.11974144	-24.55335188	24.74854183	5526.71087646	TRW
0.43359375	0.00170231	-0.00687504	0.00736332	0.00388288	-0.08593750	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-523.	476.	7752.	-0.22	0.74	2.66

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
7784.	2.77

TIME U.T.
4/ 4/68 16 HRS 19 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 19 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.25104858E 00	-0.25689635E 01	-0.13258055E 01	0.19691634E 01	-0.95713792E 00	-0.12964848E 01	RTCC
0.25074032E 00	-0.25688148E 01	-0.13262665E 01	0.19688350E 01	-0.95708585E 00	-0.12968532E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57483803.00	0.63426347	32.56851816	42.05530691	104.87909222	133.19773865	RTCC
57482295.50	0.63429216	32.58003330	42.05085993	104.87553692	133.20267677	TRW
1507.50	-0.00002868	-0.01151514	0.00444698	0.00355530	-0.00493813	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.67935562	12019.79748535	18.74984741	RTCC
384.66422272	12019.66345215	18.38775635	TRW
0.01513290	0.13403320	0.36209106	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
14790.5533	50.74583006	108.66295052	-27.18680000	30.01094294	6552.21282959	RTCC
14790.0535	50.74387980	108.66997242	-27.19650197	30.00445437	6552.39312744	TRW
0.49987793	0.00195026	-0.00702190	0.00970197	0.00648856	-0.18029785	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-1097.	2504.	11700.	-0.55	1.09	2.61

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
12015.	2.88

TIME U.T.
4/ 4/68 16 HRS 24 MIN 42.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 24 MIN 41.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.41752877E 00	-0.26430245E 01	-0.14322072E 01	0.19476068E 01	-0.78845373E 00	-0.12072567E 01	RTCC
0.41723303E 00	-0.26428712E 01	-0.14326682E 01	0.19473291E 01	-0.78840406E 00	-0.12075729E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57483361.00	0.63426631	32.56883955	42.05361748	104.87904739	136.35911179	RTCC
57481704.00	0.63429182	32.57961321	42.04952860	104.87595367	136.36358261	TRW
1657.00	-0.00002551	-0.01077366	0.00408888	0.00309372	-0.00447083	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE				
384.67491531	12019.70532227	18.69638062				RTCC
384.65827942	12019.50085449	18.35531616				TRW
0.01663589	0.20446777	0.34106445				(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
14085.8290	51.02294159	107.08493996	-28.15766597	32.12807274	7010.93865967	RTCC
14085.3531	51.02138329	107.09090519	-28.16709876	32.12232876	7011.08819580	TRW
0.47583008	0.00155830	-0.00596523	0.00943279	0.00574398	-0.14953613	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-909.	2292.	11643.	-0.39	0.93	2.25

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11902.	2.46

TIME U.T.
4/ 4/68 16 HRS 27 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 27 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.51137528E 00	-0.26789746E 01	-0.14893181E 01	0.19322413E 01	-0.70001787E 00	-0.11586763E 01	RTCC
0.51098995E 00	-0.26788208E 01	-0.14898547E 01	0.19319283E 01	-0.70001073E 00	-0.11590203E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57482771.50	0.63426093	32.56734371	42.05407381	104.87964916	138.03776741	RTCC
57481427.00	0.63429175	32.57941008	42.04881525	104.87621689	138.04241562	TRW
1344.50	-0.00003082	-0.01206636	0.00525856	0.00343227	-0.00464821	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.66899872	12019.49597168	18.71176147	RTCC
384.65550232	12019.42590332	18.33926392	TRW
0.01349640	0.07006836	0.37249756	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
13713.6879	51.24810457	106.21414566	-28.63758039	33.23092270	7260.63653564	RTCC
13713.1681	51.24623585	106.22063923	-28.64823699	33.22357368	7260.84747314	TRW
0.51977539	0.00186872	-0.00649357	0.01065660	0.00734901	-0.21093750	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-1283.	3648.	13657.	-0.62	1.17	2.36

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
14194.	2.70

TIME U.T.
4/ 4/68 16 HRS 31 MIN 48.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 31 MIN 47.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.64552074E 00	-0.27237521E 01	-0.15682197E 01	0.19065311E 01	-0.58054890E 00	-0.10911523E 01	RTCC
0.64535138E 00	-0.27235819E 01	-0.15685996E 01	0.19063831E 01	-0.58045855E 00	-0.10913350E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57483036.00	0.63427918	32.57124615	42.05157614	104.87681770	140.33882141	RTCC
57481112.50	0.63429201	32.57915115	42.04782581	104.87664318	140.34198189	TRW
1923.50	-0.00001283	-0.00790501	0.00375032	0.00017452	-0.00316048	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.67164993	12019.73962402	18.55508423	RTCC
384.65234756	12019.34387207	18.31796265	TRW
0.01930237	0.39575195	0.23712158	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
13207.1399	51.65169239	104.99181271	-29.25922680	34.70408869	7608.71221924	RTCC
13206.7941	51.65122938	104.99454880	-29.26693225	34.70152092	7608.73699951	TRW
0.34582520	0.00046301	-0.00273609	0.00770545	0.00256777	-0.02478027	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-150.	202.	9402.	0.10	0.36	1.42

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
9405.	1.46

PREC 064 80 OBS MS MAN,ACC,UPDATE 4EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 16 HRS 37 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 37 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.82793297E 00	-0.27724888E 01	-0.16693075E 01	0.18662118E 01	-0.42985080E 00	-0.10024049E 01	RTCC
0.82772865E 00	-0.27722847E 01	-0.16697627E 01	0.18660885E 01	-0.42977609E 00	-0.10025603E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57482264.00	0.63428171	32.57037020	42.05337572	104.87422562	143.29300117	RTCC
57480787.50	0.63429251	32.57885408	42.04654598	104.87728882	143.29546738	TRW
1476.50	-0.00001080	-0.00848389	0.00682974	-0.00306320	-0.00246620	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.66389847	12019.55603027	18.48464966	RTCC
384.64908218	12019.26110840	18.29357910	TRW
0.01481628	0.29492188	0.19107056	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
12564.4996	52.35444260	103.36392784	-29.98161030	36.54410410	8063.02093506	RTCC
12564.2136	52.35416126	103.36502838	-29.99055099	36.54138231	8063.04656982	TRW
0.28601074	0.00028133	-0.00110054	0.00894070	0.00272179	-0.02563477	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-157.	276.	11277.	0.09	0.29	1.19

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11281.	1.23

ASCC 065 80 OBS MS MAN ACC NO UPD 1EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 16 HRS 38 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 38 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.85587809E 00	-0.27787714E 01	-0.16842417E 01	0.18595276E 01	-0.40780958E 00	-0.98908485E 00	RTCC
0.85567004E 00	-0.27785656E 01	-0.16847011E 01	0.18594050E 01	-0.40773655E 00	-0.98923771E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57482242.50	0.63428179	32.57028580	42.05319691	104.87436581	143.73078728	RTCC
57480754.00	0.63429262	32.57881308	42.04635429	104.87740135	143.73326111	TRW
1488.50	-0.00001083	-0.00852728	0.00684261	-0.00303555	-0.00247383	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.66368866	12019.55090332	18.48257446	RTCC
384.64875031	12019.25305176	18.29058838	TRW
0.01493835	0.29785156	0.19198608	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
12470.1693	52.47766209	103.11745453	-30.08183908	36.81072092	8130.87164307	RTCC
12469.8811	52.47740555	103.11850071	-30.09082198	36.80799532	8130.89630127	TRW
0.28820801	0.00025654	-0.00104618	0.00898290	0.00272560	-0.02465820	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-150.	316.	11393.	0.09	0.30	1.18

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11398.	1.22

TIME G.T.
4/ 4/68 16 HRS 47 MIN 24.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 47 MIN 23.000SEC

	X	Y	Z	XDOT	YDOT	ZDOT	
	0.11265454E 01	-0.28239824E 01	-0.18214954E 01	0.17885721E 01	-0.20659297E 00	-0.86325539E 00	RTCC
	0.11263205E 01	-0.28237665E 01	-0.18219757E 01	0.17884684E 01	-0.20653749E 00	-0.86337033E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57481877.00	0.63428314	32.57000208	42.05180931	104.87500477	147.80756378	RTCC
57480411.00	0.63429356	32.57847834	42.04458237	104.87841225	147.80988312	TRW
1466.00	-0.00001042	-0.00847626	0.00722694	-0.00340748	-0.00231934	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.66001511	12019.46557617	18.44784546	RTCC
384.64530563	12019.16979980	18.26098633	TRW
0.01470947	0.29577637	0.18685913	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
11606.3295	53.88942862	100.76601028	-30.92578077	39.20857143	8764.87548828	RTCC
11606.0450	53.88940811	100.76606750	-30.93480039	39.20614338	8764.88708496	TRW
0.28442383	0.00002050	-0.00005722	0.00901961	0.00242805	-0.01159668	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-71.	470.	11974.	0.10	0.28	0.91

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11983.	0.96

TIME L.T.
4/ 4/68 16 HRS 55 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 4 HRS 55 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.13661330E 01	-0.28408573E 01	-0.19321073E 01	0.17172230E 01	-0.44153090E-01	-0.75569730E 00	RTCC
0.13659246E 01	-0.28406720E 01	-0.19325328E 01	0.17171529E 01	-0.44130402E-01	-0.75575657E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57481359.00	0.63428493	32.57116699	42.05074167	104.87524986	151.22219467	RTCC
57480212.50	0.63429437	32.57825661	42.04210513	104.87936592	151.22403908	TRW
1146.50	-0.00000944	-0.00708961	0.00763655	-0.00411606	-0.00184441	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.65481949	12019.34301758	18.39968872	RTCC
384.64331055	12019.12402344	18.24142456	TRW
0.01150894	0.21899414	0.15826416	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
10908.5168	55.48561382	98.72620583	-31.50522399	41.08719444	9291.81921387	RTCC
10908.2798	55.48569250	98.72493935	-31.51293015	41.08524084	9291.82946777	TRW
0.23706055	-0.00007868	0.00126648	0.00770617	0.00195360	-0.01025391	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-63.	647.	10627.	0.07	0.24	0.49

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
10647.	0.55

PREC 068 51 OBS MS MAN ACC NO UPD 1EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 17 HRS 1 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 1 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.15323656E 01	-0.28399425E 01	-0.20027731E 01	0.16633454E 01	0.61513070E-01	-0.68251608E 00	RTCC
0.15321448E 01	-0.28397467E 01	-0.20032229E 01	0.16632906E 01	0.61524975E-01	-0.68255240E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57481115.00	0.63428639	32.57084560	42.05096960	104.87469006	153.51567459	RTCC
57480110.00	0.63429482	32.57813597	42.04211950	104.88003826	153.51728249	TRW
1005.00	-0.00000843	-0.00729036	0.00885010	-0.00534821	-0.00160789	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.65237808	12019.29125977	18.37121582	RTCC
384.64227295	12019.10058594	18.23095703	TRW
0.01010513	0.19067383	0.14025879	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
10456.9415	56.80119228	97.32552910	-31.82511759	42.27608109	9638.58630371	RTCC
10456.7291	56.80138254	97.32327652	-31.83308721	42.27428150	9638.59216309	TRW
0.21240234	-0.00019026	0.00225258	0.00796962	0.00179958	-0.00585938	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-36.	693.	11235.	0.07	0.21	0.32

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11256.	0.39

TIME U.T.
4/ 4/68 17 HRS 2 MIN 42.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 2 MIN 41.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.15654997E 01	-0.28385020E 01	-0.20162967E 01	0.16521389E 01	0.82007630E-01	-0.66806098E 00	RTCC
0.15652990E 01	-0.28383109E 01	-0.20167286E 01	0.16521211E 01	0.82000770E-01	-0.66805279E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480574.00	0.63429086	32.57155180	42.05399561	104.87115574	153.96831894	RTCC
57480093.00	0.63429490	32.57811403	42.04192734	104.88017464	153.96916008	TRW
481.00	-0.00000405	-0.00656223	0.01206827	-0.00901890	-0.00084114	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64693832	12019.18798828	18.29635620	RTCC
384.64210892	12019.09692383	18.22918701	TRW
0.00482941	0.09106445	0.06716919	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
10369.7639	57.08557320	97.04887104	-31.88199353	42.50276804	9705.88586426	RTCC
10369.6486	57.08572149	97.04454517	-31.88959336	42.50129271	9705.89880371	TRW
0.11535645	-0.00014830	0.00432587	0.00759983	0.00147533	-0.01293945	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-79.	435.	10730.	0.04	0.11	-0.02

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
10739.	0.12

ACNS 070 63 OBS MS MAN ACC NO UPD 2EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 17 HRS 11 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 11 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.17938586E 01	-0.28170549E 01	-0.21038373E 01	0.15712612E 01	0.21833035E 00	-0.56876864E 00	RTCC
0.17936556E 01	-0.28168652E 01	-0.21042671E 01	0.15712532E 01	0.21831415E 00	-0.56873925E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480484.00	0.63429137	32.57142639	42.05273438	104.87207794	157.04615974	RTCC
57479994.00	0.63429536	32.57799530	42.04061842	104.88111782	157.04698181	TRW
490.00	-0.00000399	-0.00656891	0.01211596	-0.00903988	-0.00082207	(RTCC TRW)

PERIOD	APOGEE	PERIGEE	
384.64604187	12019.16845703	18.28619385	RTCC
384.64112473	12019.07446289	18.21890259	TRW
0.00491714	0.09399414	0.06729126	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
9795.7921	59.25883007	95.13195705	-32.20864296	43.98257303	10152.31994629	RTCC
9795.6790	59.25908709	95.12705612	-32.21600389	43.98138142	10152.32495117	TRW
0.11315918	-0.00025702	0.00490093	0.00736094	0.00119162	-0.00500488	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-31.	498.	10698.	0.04	0.10	-0.16

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
10710.	0.20

TIME U.T.
4/ 4/68 17 HRS 19 MIN 24.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 19 MIN 23.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.20031110E 01	-0.27789602E 01	-0.21753370E 01	0.14907617E 01	0.33707065E 00	-0.47798868E 00	RTCC
0.20029184E 01	-0.27787850E 01	-0.21757385E 01	0.14907661E 01	0.33704332E 00	-0.47793634E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480363.00	0.63429192	32.57175064	42.05160093	104.87284946	159.83970261	RTCC
57479929.00	0.63429562	32.57792187	42.03944683	104.88199806	159.84043312	TRW
434.00	-0.00000370	-0.00617123	0.01215410	-0.00914860	-0.00073051	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64482498	12019.14123535	18.27365112	RTCC
384.64046478	12019.05957031	18.21249390	TRW
0.00436020	0.08166504	0.06115723	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
9308.4265	61.61565018	93.36911392	-32.41613913	45.22314405	10534.05419922	RTCC
9308.3259	61.61597109	93.36364841	-32.42285347	45.22224569	10534.05493164	TRW
0.10058594	-0.00032091	0.00546551	0.00671434	0.00089836	-0.00073242	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-6.	540.	10000.	0.04	0.09	-0.33

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
10015.	0.34

TIME U.T.
4/ 4/68 17 HRS 28 MIN 48.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 28 MIN 47.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.22292710E 01	-0.27163396E 01	-0.22424019E 01	0.13959893E 01	0.46022635E 00	-0.37900670E 00	RTCC
0.22290818E 01	-0.27161688E 01	-0.22427948E 01	0.13960073E 01	0.46018731E 00	-0.37893038E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480242.50	0.63429272	32.57171583	42.05098581	104.87316322	162.87156868	RTCC
57479877.00	0.63429608	32.57787657	42.03815985	104.88299942	162.87217712	TRW
365.50	-0.00000336	-0.00616074	0.01282597	-0.00983620	-0.00060844	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64361572	12019.11657715	18.25881958	RTCC
384.63994980	12019.04980469	18.20504761	TRW
0.00366592	0.06677246	0.05377197	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
8823.5261	64.62381554	91.44006348	-32.54336929	46.45750952	10914.74462891	RTCC
8823.4429	64.62416935	91.43373871	-32.54978466	46.45688772	10914.74096680	TRW
0.08325195	-0.00035381	0.00632477	0.00641537	0.00062180	0.00366211	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
22.	551.	9785.	0.03	0.08	-0.50

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
9800.	0.51

TIME U.T.
4/ 4/68 17 HRS 30 MIN 42.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 30 MIN 41.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.22731612E 01	-0.27013872E 01	-0.22541110E 01	0.13765348E 01	0.48363431E 00	-0.35958181E 00	RTCC
0.22729808E 01	-0.27012246E 01	-0.22544861E 01	0.13765584E 01	0.48358937E 00	-0.35949787E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480189.00	0.63429314	32.57196999	42.05096960	104.87307453	163.46569824	RTCC
57479864.00	0.63429686	32.57787085	42.03784943	104.88325882	163.46622658	TRW
325.00	-0.00000372	-0.00590086	0.01312017	-0.01018429	-0.00052834	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64307404	12019.10607910	18.25164795	RTCC
384.63981628	12019.05371094	18.19689941	TRW
0.00325775	0.05236816	0.05474854	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
8734.6394	65.27068710	91.06098557	-32.55658722	46.68576384	10984.49255371	RTCC
8734.5640	65.27094555	91.05438614	-32.56268263	46.68522453	10984.48950195	TRW
0.07543945	-0.00025845	0.00659943	0.00609541	0.00053930	0.00305176	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
18.	525.	9336.	0.02	0.07	-0.56

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
9350.	0.57

ASCC 075 23 OBS MS MAN ACC NO UPD 1EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 17 HRS 36 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 36 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.24033295E 01	-0.26512835E 01	-0.22860478E 01	0.13165635E 01	0.55229134E 00	-0.30134942E 00	RTCC
0.24031571E 01	-0.26511260E 01	-0.22864096E 01	0.13165960E 01	0.55224292E 00	-0.30125053E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480103.50	0.63429375	32.57204962	42.05072880	104.87310219	165.24562263	RTCC
57479865.50	0.63429578	32.57786798	42.03720856	104.88376427	165.24604988	TRW
238.00	-0.00000203	-0.00581837	0.01352024	-0.01066208	-0.00042725	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
384.64222336	12019.08886719	18.24072266		RTCC
384.63982773	12019.04394531	18.20721436		TRW
0.00239563	0.04492188	0.03350830		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
8481.7239	67.32369614	89.92415714	-32.57197094	47.34348392	11182.73181152	RTCC
8481.6689	67.32404327	89.91705513	-32.57777405	47.34313202	11182.72814941	TRW
0.05493164	-0.00034714	0.00710201	0.00580311	0.00035191	0.00366211	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
23.	472.	8999.	0.03	0.05	-0.66

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
9012.	0.67

TIME U.T.
4/ 4/68 17 HRS 45 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 45 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.25957712E 01	-0.25598263E 01	-0.23249974E 01	0.12207060E 01	0.65226678E 00	-0.21288579E 00	RTCC
0.25955993E 01	-0.25596747E 01	-0.23253481E 01	0.12207416E 01	0.65221610E 00	-0.21277648E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480149.00	0.63429295	32.57198620	42.04930162	104.87436962	167.94979858	RTCC
57479873.00	0.63429473	32.57788277	42.03616047	104.88460445	167.95029259	TRW
276.00	-0.00000179	-0.00589657	0.01314116	-0.01023483	-0.00049400	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
384.64267349	12019.09338379	18.25109863		RTCC
384.63990021	12019.03613281	18.21752930		TRW
0.00277328	0.05725098	0.03356934		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
8139.6456	70.77300262	88.19714260	-32.52754116	48.27010822	11449.97656250	RTCC
8139.5922	70.77353573	88.18989277	-32.53308916	48.26990700	11449.96154785	TRW
0.05340576	-0.00053310	0.00724983	0.00554800	0.00020123	0.01501465	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
90.	544.	8749.	0.04	0.04	-0.73

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
8766.	0.73

TIME U.T.
4/ 4/68 17 HRS 54 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 54 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.27697518E 01	-0.24563246E 01	-0.23503527E 01	0.11248045E 01	0.74195671E 00	-0.12929278E 00	RTCC
0.27695906E 01	-0.24561852E 01	-0.23506767E 01	0.11248468E 01	0.74190114E 00	-0.12916897E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480127.50	0.63429275	32.57217073	42.04843283	104.87502480	170.51105881	RTCC
57479871.50	0.63429404	32.57792187	42.03518009	104.88537598	170.51153564	TRW
256.00	-0.00000129	-0.00575113	0.01325274	-0.01035118	-0.00047684	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64245987	12019.08581543	18.25158691	RTCC
384.63988495	12019.02917480	18.22399902	TRW
0.00257492	0.05664063	0.02758789	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
7868.4391	74.39470387	86.56831837	-32.41070700	49.07168579	11660.69323730	RTCC
7868.3981	74.39533138	86.56069660	-32.41577291	49.07164478	11660.67150879	TRW
0.04107666	-0.00062752	0.00762177	0.00506592	0.00004101	0.02172852	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
131.	543.	8095.	0.05	0.03	-0.82

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
8114.	0.83

TIME U.T.
4/ 4/68 18 HRS 4 MIN 24.000 SEC

TIME FROM LAUNCH
0 DAYS 6 HRS 4 MIN 23.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.29463278E 01	-0.23262137E 01	-0.23642614E 01	0.10154420E 01	0.83348498E 00	-0.39090740E-01	RTCC
0.29462098E 01	-0.23261094E 01	-0.23645096E 01	0.10155054E 01	0.83341525E 00	-0.38939215E-01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57479873.50	0.63429481	32.57300425	42.04910564	104.87397003	173.28785324	RTCC
57479868.50	0.63429362	32.57798910	42.03412485	104.88619518	173.28802109	TRW
5.00	0.00000119	-0.00498486	0.01498079	-0.01222515	-0.00016785	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE				
384.63991165	12019.03698730	18.21685791				RTCC
384.63985825	12019.02441406	18.22784424				TRW
0.00005341	0.01257324	-0.01098633				(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
7639.5567	78.67121220	84.81751347	-32.20300388	49.86563730	11837.40246582	RTCC
7639.5585	78.67153645	84.80874920	-32.20679760	49.86577368	11837.40002441	TRW
-0.00177002	-0.00032425	0.00876427	0.00379372	-0.00013638	0.00244141	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
15.	373.	6138.	0.01	-0.00	-1.04

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
6150.	1.04

TIME U.T.
4/ 4/68 18 HRS 6 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 6 HRS 6 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.29764650E 01	-0.23009512E 01	-0.23652365E 01	0.99523376E 00	0.84927192E 00	-0.22955660E-01	RTCC
0.29763723E 01	-0.23008695E 01	-0.23654355E 01	0.99530105E 00	0.84920001E 00	-0.22800610E-01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57479811.00	0.63429520	32.57370758	42.04914284	104.87380219	173.78639221	RTCC
57479873.00	0.63429344	32.57800388	42.03393841	104.88634205	173.78647614	TRW
-62.00	0.00000177	-0.00429630	0.01520443	-0.01253986	-0.00008392	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
384.63928604	12019.02380371	18.20935059		RTCC
384.63990402	12019.02380371	18.22979736		TRW
-0.00061798	0.	-0.02044678		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
7606.1637	79.47252846	84.50512695	-32.15732574	50.00079632	11863.08178711	RTCC
7606.1743	79.47274113	84.49632168	-32.16034412	50.00091600	11863.08691406	TRW
-0.01055908	-0.00021267	0.00880527	0.00301838	-0.00011969	-0.00512695	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-31.	305.	4892.	0.00	-0.01	-1.07

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
4901.	1.07

ASCC 080 72 OBS MS MAN ACC NO UPD 1EDIT 2ITER VEH 1

TIME U.T.
4/ 4/68 18 HRS 7 MIN 42.000 SEC

TIME FROM LAUNCH
0 DAYS 6 HRS 7 MIN 41.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.30011344E 01	-0.22795535E 01	-0.23656482E 01	0.97831831E 00	0.86223459E 00	-0.95616400E-02	RTCC
0.30010435E 01	-0.22794771E 01	-0.23658380E 01	0.97838391E 00	0.86216339E 00	-0.94079430E-02	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57479848.50	0.63429464	32.57382107	42.04871321	104.87422943	174.20049095	RTCC
57479876.00	0.63429327	32.57801676	42.03378439	104.88646507	174.20062065	TRW
-27.50	0.00000137	-0.00419569	0.01492882	-0.01223564	-0.00012970	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.63965225	12019.02868652	18.21691895	RTCC
384.63993835	12019.02319336	18.23153687	TRW
-0.00028610	0.00549316	-0.01461792	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
7580.2813	80.14497185	84.24594879	-32.11681080	50.11153078	11882.98559570	RTCC
7580.2872	80.14523697	84.23730183	-32.11969185	50.11161947	11882.98693848	TRW
-0.00592041	-0.00026512	0.00864697	0.00288105	-0.00008869	-0.00134277	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-9.	347.	4670.	0.01	-0.01	-1.06

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
4683.	1.06

TIME U.T.
4/ 4/68 18 HRS 33 MIN 48.000 SEC

TIME FROM LAUNCH
0 DAYS 6 HRS 33 MIN 47.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.33607572E 01	-0.18592495E 01	-0.23201180E 01	0.67058766E 00	0.10625653E 01	0.21720948E 00	RTCC
0.33606899E 01	-0.18592073E 01	-0.23202397E 01	0.67065333E 00	0.10624945E 01	0.21736857E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480004.50	0.63429087	32.57424974	42.04508018	104.87730503	181.30566406	RTCC
57479981.50	0.63429000	32.57832384	42.03123903	104.88844299	181.30591965	TRW
23.00	0.00000087	-0.00407410	0.01384115	-0.01113796	-0.00025558	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64122772	12019.03491211	18.26196289	RTCC
384.64099121	12019.02050781	18.26879883	TRW
0.00023651	0.01440430	-0.00683594	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
7411.8546	92.26216507	79.90354824	-31.13519263	51.83526230	12012.07604980	RTCC
7411.8704	92.26259995	79.89522171	-31.13704658	51.83532715	12012.05883789	TRW
-0.01580811	-0.00043488	0.00832653	0.00185394	-0.00006485	0.01721191	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
104.	442.	3007.	0.02	-0.02	-1.08

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
3041.	1.08

TIME U.T.
4/ 4/68 18 HRS 57 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 6 HRS 57 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.35665343E 01	-0.14077850E 01	-0.21939198E 01	0.36139829E 00	0.12081904E 01	0.41865797E 00	RTCC
0.35664775E 01	-0.14077612E 01	-0.21940045E 01	0.36145605E 00	0.12081275E 01	0.41880705E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480218.50	0.63428590	32.57470894	42.04060507	104.88095951	187.83651352	RTCC
57480151.50	0.63428604	32.57873821	42.02905846	104.89001656	187.83687973	TRW
67.00	-0.00000014	-0.00402927	0.01154661	-0.00905704	-0.00036621	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE				
384.64336395	12019.04541016	18.32189941				RTCC
384.64270020	12019.02868652	18.31655884				TRW
0.00066376	0.01672363	0.00534058				(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
7723.6985	103.10002041	76.13985157	-29.77729797	53.28118944	11772.62390137	RTCC
7723.7307	103.10059738	76.13255024	-29.77864742	53.28120995	11772.58483887	TRW
-0.03222656	-0.00057697	0.00730133	0.00134945	-0.00002050	0.03906250	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
236.	494.	2121.	0.04	-0.02	-1.00

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
2190.	1.00

TIME U.T.
4/ 4/68 19 HRS 21 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 7 HRS 21 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.36422615E 01	-0.90084346E 00	-0.19856762E 01	0.88421000E-02	0.13205532E 01	0.62299569E 00	RTCC
0.36423187E 01	-0.90080564E 00	-0.19855712E 01	0.89356606E-02	0.13206161E 01	0.62312329E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480680.50	0.63427509	32.57717228	42.02824354	104.89114761	194.79587364	RTCC
57483131.50	0.63420230	32.57877970	42.01825190	104.89835262	194.79820633	TRW
-2451.00	0.00007279	-0.00160742	0.00999165	-0.00720501	-0.00233269	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.64801025	12019.06750488	18.45193481	RTCC
384.67261124	12019.03820801	19.28808594	TRW
-0.02460098	0.02929688	-0.83615112	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
8487.4701	112.72458553	72.43975258	-27.88912797	54.91272688	11178.34619141	RTCC
8488.1204	112.72132301	72.43392277	-27.88758206	54.91349554	11178.31823730	TRW
-0.65026855	0.00326252	0.00582981	-0.00154591	-0.00076866	0.02795410	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
170.	-1729.	-1966.	-0.04	-0.72	-0.67

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
2624.	0.99

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TIME U.T.
4/ 4/68 19 HRS 45 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 7 HRS 45 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.35661208E 01	-0.35912327E 00	-0.16958791E 01	-0.40379555E 00	0.13915771E 01	0.83356561E 00	RTCC
0.35661858E 01	-0.35902505E 00	-0.16957959E 01	-0.40381528E 00	0.13917219E 01	0.83346508E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57481352.00	0.63426215	32.58350372	42.00889015	104.90632915	202.51391602	RTCC
57483627.50	0.63419729	32.57954502	42.01610518	104.89933586	202.51675034	TRW
-2275.50	0.00006486	0.00395870	-0.00721502	0.00699329	-0.00283432	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.65475082	12019.12561035	18.61477661	RTCC
384.67759705	12019.12414551	19.36535645	TRW
-0.02284622	0.00146484	-0.75057983	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
9716.7308	120.39241219	68.77551842	-25.32162714	57.06304789	10214.27331543	RTCC
9717.1682	120.38849831	68.78029728	-25.32020140	57.06471443	10214.32153320	TRW
-0.43737793	0.00391388	-0.00477886	-0.00142574	-0.00166655	-0.04821777	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-293.	-2781.	-1135.	-0.07	-0.55	0.87

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
3018.	1.03

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TIME U.T.
4/ 4/68 20 HRS 9 MIN 30.000 SEC

TIME FROM LAUNCH
0 DAYS 8 HRS 9 MIN 29.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.33062101E 01	0.20204004E 00	-0.13181182E 01	-0.91654386E 00	0.14010234E 01	0.10576684E 01	RTCC
0.33062533E 01	0.20224670E 00	-0.13181337E 01	-0.91664648E 00	0.14012160E 01	0.10573726E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57482386.50	0.63425544	32.58984566	41.99442244	104.91623783	211.73385429	RTCC
57484630.00	0.63419334	32.58061790	42.01389170	104.89968109	211.73701668	TRW
-2243.50	0.00006210	0.00922775	-0.01946926	0.01655674	-0.00316238	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE				
384.66513062	12019.34057617	18.74057007				RTCC
384.68765259	12019.35632324	19.46313477				TRW
-0.02252197	-0.01574707	-0.72256470				(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
11510.8901	125.91699505	65.06787205	-21.69944859	60.29411364	8836.30651855	RTCC
11511.0403	125.91254902	65.08047676	-21.69934893	60.29763794	8836.50500488	TRW
-0.15014648	0.00444603	-0.01260471	-0.00009966	-0.00352430	-0.19848633	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-1206.	-3919.	1678.	-0.15	-0.29	2.11

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
4430.	2.14

TIME U.T.
4/ 4/68 20 HRS 28 MIN 6.000 SEC

TIME FROM LAUNCH
0 DAYS 8 HRS 28 MIN 5.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.29465983E 01	0.62792990E 00	-0.96186107E 00	-0.14242422E 01	0.13312793E 01	0.12418865E 01	RTCC
0.29465989E 01	0.62824336E 00	-0.96202907E 00	-0.14243618E 01	0.13314736E 01	0.12414720E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
37484042.50	0.63425652	32.59451056	41.98510551	104.92128181	220.70501900	RTCC
37486280.50	0.63419463	32.58176708	42.01217127	104.89904499	220.70817757	TRW
-2238.00	0.00006188	0.01274347	-0.02706575	0.02223682	-0.00315857	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.68175125	12019.79602051	18.83001709	RTCC
384.70422363	12019.81250000	19.55020142	TRW
-0.02247238	-0.01647949	-0.72018433	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
13436.0928	128.54469681	62.17775488	-17.70631552	64.16439915	7450.37298584	RTCC
13435.8777	128.54001427	62.19473171	-17.70885205	64.17022896	7450.76507568	TRW
0.21508789	0.00468254	-0.01697683	0.00253654	-0.00582981	-0.39208984	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-2383.	-4306.	5583.	-0.31	0.03	2.73

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
7442.	2.75

TIME U.T.
4/ 4/68 20 HRS 36 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 8 HRS 36 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.27367580E 01	0.80327869E 00	-0.78839893E 00	-0.16907400E 01	0.12637659E 01	0.13239907E 01	RTCC
0.27366997E 01	0.80377241E 00	-0.78889985E 00	-0.16908308E 01	0.12639755E 01	0.13234255E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57485066.00	0.63426521	32.60029745	41.96601868	104.93459606	225.42842865	RTCC
57487539.00	0.63419854	32.58238029	42.01145887	104.89830589	225.43039894	TRW
-2473.00	0.00006667	0.01791716	-0.04544020	0.03629017	-0.00197029	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
384.69202805	12020.15344238	18.80941772		RTCC
384.71685410	12020.18786621	19.58905029		TRW
-0.02482605	-0.03442383	-0.77963257		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
14483.6202	129.15600395	60.93173742	-15.45169711	66.46162415	6749.83380127	RTCC
14482.8511	129.15085602	60.95679283	-15.46061563	66.47146988	6750.56939697	TRW
0.76916504	0.00514793	-0.02505541	0.00891852	-0.00984573	-0.73559570	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-4472.	-4288.	13406.	-0.72	0.41	3.45

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
14768.	3.54

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TIME U.T.
4/ 4/68 20 HRS 44 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 8 HRS 44 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.24917858E 01	0.96538000E 00	-0.60640835E 00	-0.19909220E 01	0.11616802E 01	0.14038831E 01	RTCC
0.24917062E 01	0.96596304E 00	-0.60708944E 00	-0.19909151E 01	0.11618601E 01	0.14033227E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57486835.50	0.63427661	32.60250044	41.95894861	104.93826771	230.81144333	RTCC
57499392.50	0.63420668	32.58305454	42.01081991	104.89714241	230.81253052	TRW
-2557.00	0.00006993	0.01944590	-0.05187130	0.04112530	-0.00108719	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.70979691	12020.73742676	18.80804443	RTCC
384.73545837	12020.76354980	19.62359619	TRW
-0.02566147	-0.02612305	-0.81555176	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
15688.0144	129.36612701	59.75136375	-12.78545332	69.27602005	5995.71697998	RTCC
15686.7408	129.36095428	59.77785778	-12.79870844	69.28829384	5996.69439697	TRW
1.27355957	0.00517273	-0.02649403	0.01325512	-0.01227379	-0.97741699	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-5943.	-3673.	17492.	-1.13	0.72	3.15

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
18835.	3.42

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TIME U.T.
4/ 4/68 20 HRS 52 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 8 HRS 52 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.22038017E 01	0.11107332E 01	-0.41416570E 00	-0.23374186E 01	0.10075712E 01	0.14787497E 01	RTCC
0.22037361E 01	0.11113058E 01	-0.41489249E 00	-0.23372698E 01	0.10077175E 01	0.14783085E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57489823.50	0.63429070	32.60197592	41.96073532	104.93502140	237.17573929	RTCC
57492275.50	0.63422266	32.58377123	42.01030350	104.89540005	237.17603683	TRW
-2452.00	0.00006804	0.01820469	-0.04956818	0.03962135	-0.00029755	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.73978043	12021.67431641	18.85464478	RTCC
384.76440811	12021.69006348	19.64602661	TRW
-0.02462769	-0.01574707	-0.79138184	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
17110.9148	129.08737946	58.67308426	-9.52671301	72.84139633	5176.75421143	RTCC
17109.2314	129.08277130	58.69653797	-9.54236770	72.85395050	5177.84527588	TRW
1.68334961	0.00460815	-0.02345371	0.01565468	-0.01255417	-1.09106445	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-6632.	-2234.	18103.	-1.56	0.90	2.19

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
19409.	2.84

TIME U.T.
4/ 4/68 21 HRS 0 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 9 HRS 0 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.18658807E 01	0.12307419E 01	-0.21294635E 00	-0.27418296E 01	0.77311941E 00	0.15402607E 01	RTCC
0.18658570E 01	0.12311491E 01	-0.21345185E 00	-0.27416334E 01	0.77326720E 00	0.15399700E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57494953.00	0.63430887	32.59871292	41.97648764	104.92077732	244.94035339	RTCC
57496887.00	0.63425326	32.58444309	42.00998402	104.89306259	244.94089508	TRW
-1934.00	0.00005561	0.01426983	-0.03349638	0.02771473	-0.00054169	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.79127884	12023.22570801	18.99139404	RTCC
384.81069565	12023.21984863	19.63406372	TRW
-0.01941681	0.00585938	-0.64266968	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
18824.3228	128.15637016	57.80922985	-5.44205081	77.49645329	4291.48197256	RTCC
18822.7585	128.15295029	57.82559776	-5.45439547	77.50550079	4292.34826660	TRW
1.56420898	0.00341988	-0.01636791	0.01234466	-0.00904751	-0.86639404	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-5266.	-861.	12501.	-1.58	0.75	1.36

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
13593.	2.21

TIME U.T.
4/ 4/68 21 HRS 8 MIN 12.000 SEC

TIME FROM LAUNCH
0 DAYS 9 HRS 8 MIN 11.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.14695511E 01	0.13115055E 01	-0.53744200E-02	-0.32155880E 01	0.40824864E 00	0.15697175E 01	RTCC
0.14695319E 01	0.13117743E 01	-0.56316142E-02	-0.32154782E 01	0.40841921E 00	0.15694113E 01	TPW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57503110.50	0.63435533	32.59747934	41.99189949	104.90605545	254.80375481	RTCC
57504453.00	0.63431133	32.58479548	42.00990582	104.89061069	254.80523300	TRW
-1342.50	0.00004400	0.01268387	-0.01800632	0.01544476	-0.00147820	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
384.87318039	12025.85986328	19.04266357	RTCC
384.88665009	12025.80444336	19.53988647	TRW
-0.01346970	0.05541992	-0.49722290	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
20934.3633	126.28869438	57.40285492	-0.15633570	83.82940483	3342.11813354	RTCC
20933.1296	126.28609371	57.41557121	-0.16380345	83.83560658	3342.68777466	TRW
1.23364258	0.00260067	-0.01271629	0.00746775	-0.00620174	-0.56964111	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-3462.	-867.	6930.	-1.14	0.69	1.67

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
7795.	2.14

TIME U.T.
4/ 4/68 21 HRS 16 MIN 54.000 SEC

TIME FROM LAUNCH
0 DAYS 9 HRS 16 MIN 53.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.96114154E 00	0.13279437E 01	0.21945081E 00	-0.38062673E 01	-0.24562857E 00	0.15114611E 01	RTCC
0.96117092E 00	0.13278572E 01	0.21947686E 00	-0.38064862E 01	-0.24499879E 00	0.15112300E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
5751 8695.50	0.63440219	32.58244705	42.01243496	104.88985443	269.37443542	RTCC
5751 8275.50	0.63435687	32.57602072	42.00494289	104.88398838	269.38501740	TRW
420.00	0.00004531	0.00642633	0.00749207	0.00586605	-0.01058197	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
385.02964783	12030.49536133	19.53698730	RTCC
385.02544022	12029.95336914	19.94070435	TRW
0.00420761	0.54199219	-0.40371704	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
23848.0476	122.56998634	58.22627974	7.62488246	94.00469303	2254.57931519	RTCC
23848.5146	122.56510258	58.23315620	7.62602001	94.00209141	2254.41085815	TRW
-0.46704102	0.00488377	-0.00687647	-0.00113755	0.00260162	0.16845703	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
1023.	964.	-1405.	-2.02	-1.85	3.05

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
1987.	4.10

TIME U.T.
4/ 4/68 21 HRS 24 MIN 54.000 SEC

TIME FROM LAUNCH
0 DAYS 9 HRS 24 MIN 53.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.41708451E 00	0.12331665E 01	0.40709244E 00	-0.43343206E 01	-0.12619617E 01	0.12542810E 01	RTCC
0.41709764E 00	0.12331210E 01	0.40710913E 00	-0.43346199E 01	-0.12613666E 01	0.12541015E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57532380.00	0.63455105	32.57578468	42.00966501	104.90458488	288.76056671	RTCC
57532023.50	0.63451285	32.57163811	42.00106239	104.89888382	288.77305984	TRW
356.50	0.00003820	0.00414658	0.00860262	0.00570107	-0.01249313	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
385.16706848	12035.58593750	18.95080566	RTCC
385.16349030	12035.12841797	19.29110718	TRW
0.00357819	0.45751953	-0.34030151	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
27234.3076	116.51925945	61.99697876	17.36536551	109.20886517	1256.03970337	RTCC
27234.7073	116.51393032	62.00264263	17.36652255	109.20767689	1255.92892456	TRW
-0.39965820	0.00532913	-0.00566387	-0.00115705	0.00118828	0.11077881	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
673.	229.	-775.	-2.28	-1.59	2.89

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
1051.	4.01

GW4S 097 16 OBS SS MAN,ACC NO UPD 1EDIT 7 ITER VEH 1

TIME J.T.
4/ 4/68 21 HRS 30 MIN 0. SEC

TIME FROM LAUNCH
0 DAYS 9 HRS 29 MIN 59.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.39755700E-01	0.10874189E 01	0.49881942E 00	-0.45137874E 01	-0.22132535E 01	0.88443187E 00	RTCC
0.39442142E-01	0.10871443E 01	0.49932869E 00	-0.45141631E 01	-0.22144534E 01	0.87833948E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57785937.00	0.63611203	32.59048700	42.09372950	104.73150539	305.95169067	RTCC
57759061.50	0.63609397	32.57475090	41.99822955	104.89384842	305.89376831	TRW
26875.50	0.00001806	0.01573610	0.09550095	-0.16234303	0.05792236	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
387.71612930	12118.64123535	19.35562134	RTCC
387.44568253	12111.23291016	17.91778564	TRW
0.27044678	7.40832520	1.43783569	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
29670.4207	110.55208874	67.94905663	24.62731171	124.52322578	681.14895630	RTCC
29659.2627	110.57264519	68.00551510	24.65517378	124.53925610	680.98526001	TRW
1.15795898	-0.02055645	-0.05645847	-0.02786207	-0.01603031	0.16369629	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
991.	-10468.	-8908.	21.18	9.16	27.84

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
13781.	36.16

GWMS 038 13 OBS MS MAN ACC NO UPD IEDIT 5 ITER VEH 1

TIME J.T.
4/ 4/68 21 HRS 31 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 9 HRS 31 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.8063+980E-01	0.10238497E 01	0.52023535E 00	-0.45056607E 01	-0.25521557E 01	0.71615901E 00	RTCC
-0.80940330E-01	0.10234964E 01	0.52056708E 00	-0.45074398E 01	-0.25619156E 01	0.71013296E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57795763.50	0.63629060	32.59341288	42.10512972	104.77941418	312.24224472	RTCC
57811180.00	0.63643859	32.57272482	41.99296141	104.89602661	312.24302292	TRW
-15416.50	-0.00014799	0.02068806	0.11216831	-0.11661243	-0.00077820	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE				
387.81503296	12122.99583984	18.24554443				RTCC
387.97021866	12128.54553223	17.76028442				TRW
-0.15518570	-5.55969238	0.48526001				(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
30414.6719	108.25897884	70.81106949	26.86442161	130.71909714	523.54235840	RTCC
30418.1213	108.26147079	70.88139725	26.88653183	130.73763466	523.05078125	TRW
-3.44946289	-0.00249195	-0.07032776	-0.02211022	-0.01853752	0.49157715	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
2984.	-9614.	-6506.	13.87	0.92	33.80

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11936.	36.55

GWMS 095 15 OBS MS MAN ACC NO UPD 1EDIT 4ITER VEH 1

TIME J.T. TIME FROM LAUNCH
4/ 4/68 21 HRS 32 MIN 54.000 SEC 0 DAYS 9 HRS 32 MIN 53.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.17803750E 00	0.96529205E 00	0.53411837E 00	-0.44677813E 01	-0.28557412E 01	0.55945842E 00	RTCC
-0.17824189E 00	0.96481609E 00	0.53428918E 00	-0.44688463E 01	-0.28562168E 01	0.55349836E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
5783>184.50	0.63645008	32.58456612	42.08785629	104.76727390	317.79577255	RTCC
5780>382.00	0.63641950	32.57080412	41.98680019	104.90727139	317.76163101	TRW
29802.50	0.00003058	0.01376200	0.10105610	-0.13999748	0.03414154	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
383.22194672	12135.38940430	19.14706421	RTCC
387.92191315	12127.07165527	17.65487671	TRW
0.30003357	8.31774902	1.49218750	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
30992.8503	106.20196342	73.59022713	28.55274272	136.33849144	407.17767334	RTCC
30995.9033	106.21420574	73.65371799	28.57086802	136.35699272	406.17187500	TRW
-3.05297852	-0.01224232	-0.06349087	-0.01812530	-0.01850128	1.00579834	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
6110.	-8446.	-5231.	17.97	2.02	30.32

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
11663.	35.30

HIGH SPEED TELEMETRY VECTOR

TIME G.E.T.
4/ 4/68 15 HRS 23 MIN 40.150 SEC

TIME FROM LAUNCH
0 DAYS 3 HRS 23 MIN 39.150SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.10109424E 01	-0.13522995E 00	0.36822089E 00	-0.13714098E 01	-0.49492484E 01	-0.17603461E 01	RTCC
-0.10108630E 01	-0.13442402E 00	0.36907070E 00	-0.13772890E 01	-0.49489547E 01	-0.17579144E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57498404.00	0.63456158	32.56029320	42.04724836	104.91405201	35.96578455	RTCC
57566582.50	0.63498285	32.58024836	42.07056189	104.82717896	35.97546768	TRW
-68178.50	-0.00042126	-0.01995516	-0.02331352	0.08687305	-0.00968313	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
384.82593155	12026.54565430	16.80764771		RTCC
385.51058960	12048.87768555	16.91699219		TRW
-0.68465805	-22.33203125	-0.10934448		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
31557.4971	76.16769505	116.35396194	19.85057950	316.06951904	293.18652344	RTCC
31560.0127	76.15821075	116.34645367	19.89613271	316.02523041	293.58139038	TRW
-2.51562500	0.00948429	0.00750828	-0.04555321	0.04428864	-0.39486694	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-2412.	22790.	-8843.	-36.45	6.37	1.10

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
24564.	37.02

HIGH SPEED RADAR CUTOFF VECTOR FOLLOWING SPS-1

TIME U.T.
4/ 4/68 15 HRS 24 MIN 49.400 SEC

TIME FROM LAUNCH
0 DAYS 3 HRS 24 MIN 48.400SEC

X	Y	Z	XDOT	YDOT	ZDOT	
-0.10344151E 01	-0.22888140E 00	0.33427602E 00	-0.10781610E 01	-0.48973883E 01	-0.18610864E 01	RTCC
-0.10344801E 01	-0.22915502E 00	0.33424267E 00	-0.10806434E 01	-0.48963857E 01	-0.18602690E 01	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57602559.00	0.63502923	32.57429934	42.07106543	104.93546104	41.08572865	RTCC
57570295.50	0.63499109	32.58227348	42.06776524	104.83875179	41.19841194	TRW
32263.50	0.00003814	-0.00797415	0.00330019	0.09670925	-0.11268330	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE	
385.87203598	12058.99816895	18.63848877	RTCC
385.54788589	12049.95495605	17.06192017	TRW
0.32415009	9.04321289	1.57656860	(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
31091.4438	74.23872948	117.91463947	17.51168871	320.63778687	384.58886719	RTCC
31087.3677	74.19724560	117.92636395	17.50814652	320.65147781	384.95697021	TRW
4.07617188	0.04148388	-0.01172447	0.00354218	-0.01369095	-0.36810303	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
-2237.	-5352.	-1210.	-13.66	8.10	3.53

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
5926.	16.27

AGC NAV UPDATE PRIOR TO ENTRY

TIME U.T.
4/ 4/68 17 HRS 45 MIN 36.000 SEC

TIME FROM LAUNCH
0 DAYS 5 HRS 45 MIN 35.000SEC

X	Y	Z	XDOT	YDOT	ZDOT	
0.25957712E 01	-0.25598263E 01	-0.23249974E 01	0.12207060E 01	0.65226678E 00	-0.21288579E 00	RTCC
0.25955993E 01	-0.25596747E 01	-0.23253481E 01	0.12207416E 01	0.65221610E 00	-0.21277648E 00	TRW

DIFFERENCES IN OSCULATING ELEMENTS (RTCC - TRW)

SEMI-MAJOR	ECCEN	INCL	NODE	ARG PERIGEE	TRUE ANOM	
57480149.00	0.63429295	32.57198620	42.04930162	104.87436962	167.94979858	RTCC
57479873.00	0.63429473	32.57788277	42.03616047	104.88460445	167.95029259	TRW
276.00	-0.00000179	-0.00589657	0.01314116	-0.01023483	-0.00049400	(RTCC-TRW)

PERIOD	APOGEE	PERIGEE		
384.64267349	12019.09338379	18.25109863		RTCC
384.63990021	12019.03613281	18.21752930		TRW
0.00277328	0.05725098	0.03356934		(RTCC-TRW)

VEL-MAG	FLT PATH	HEADING	DECLIN	LONG	HEIGHT	
8139.6456	70.77300262	88.19714260	-32.52754116	48.27010822	11449.97656250	RTCC
8139.5922	70.77353573	88.18989277	-32.53308916	48.26990700	11449.96154785	TRW
0.05340576	-0.00053310	0.00724983	0.00554800	0.00020123	0.01501465	(RTCC-TRW)

DIFFERENCE BETWEEN RTCC AND TRW VECTORS IN UVW COORDINATES (FT,FT/SEC)

DELTA U	DELTA V	DELTA W	DELTA UDOT	DELTA VDOT	DELTA WDOT
90.	544.	8749.	0.04	0.04	-0.73

MAGNITUDE OF VECTOR DIFFERENCE (FT,FT/SEC)

DELTA POS	DELTA VEL
8766.	0.73

APPENDIX B

SUPPLEMENTARY DATA

Information which is too detailed for the body of the report is presented in this appendix. This information includes a summary of radar observations, a summary of station locations, a summary of drag values for various phases of the mission, and a summary of the radar data weights used in ESPOD.

Table B-1, a summary of data observations, lists the time of the first valid data point with an elevation above 3 degrees (rise time) and the elevation of this data point (rise elevation), the maximum elevation of the pass, the time of the last valid data point with an elevation above 3 degrees (set time) and the elevation of this data point (set elevation), and the number of valid data points by station and revolution.

Table B-2 lists the C-band station locations used in ESPOD. These locations are referenced to the Fischer Ellipsoid of 1960.

Table B-3 lists the S-band station locations used in ESPOD. These locations are referenced to the Fischer Ellipsoid of 1960.

Table B-4, the drag summary, lists the vehicle configuration, the time interval for which the listed drag value is valid, vehicle weight for this time interval, vehicle cross sectional area, and the value of the drag parameter.

Table B-5 lists the values used by ESPOD to weight the radar tracking data from each station as a function of data type and radar type.

Table B-1. Summary of Observations

Station	Revolution	Date (yr:mo:day)	Rise Time, GMT (hr:min:sec)	Rise * Elevation (deg)	Maximum * Elevation (deg)	Set Time, GMT (hr:min:sec)	Set * Elevation (deg)	Number of Observations
MILS	3	68:04:04	15:14:36	16.97	27.65	15:18:24	2.87	39
PATC	3	68:04:04	15:14:42	17.07	23.20	15:18:00	4.84	34
MLAC	3	68:04:04	15:15:06	23.20	27.03	15:18:00	4.80	29
BDQC	3	68:04:04	15:16:12	3.41	22.75	15:22:36	2.72	58
BDAS	3	68:04:04	15:16:12	3.44	22.74	15:22:36	2.72	58
ANTC	3	68:04:04	15:18:48	2.93	9.49	15:26:18	2.79	72
ACNS	3	68:04:04	15:26:54	2.87	66.58	18:09:06	13.09	1336
ASCC	3	68:04:04	15:34:54	66.78	68.58	1829:36	12.02	1198
CROC	3	68:04:04	16:02:06	2.82	89.17	18:32:06	24.10	971
TANC	3	68:04:04	16:43:30	70.02	74.72	16:45:18	74.72	16
CROS	3	68:04:04	17:27:42	18.09	27.59	21:23:30	4.04	2307
GWMS	3	68:04:04	21:16:48	2.67	13.72	21:33:41	9.25	177

*These angles have been corrected for refraction effects.

Table B-2. C-band Station Locations

Station	Radar Type	Identification	Latitude* (deg)	Longitude* (deg)	Altitude* (deg)
Antigua	FPQ-6	ANT	17.14403	298.20714	190.29
Ascension	TPQ-18	ASC	-7.97276	345.59830	469.16
Ascension	FPS-16	ASC	-7.95151	345.58740	360.90
Bermuda	FPS-16	BDA	32.34810	295.34620	59.06
Bermuda	FPQ-6	BDQ	32.34796	295.34626	62.34
California	FPS-16	CAL	34.58290	239.43885	2119.42
California	TPQ-18	CLQ	34.66598	239.41780	354.33
Canary Island	MPS-26	CYI	27.76321	344.36519	551.18
Cape Kennedy	FPS-16	CNV	28.48177	279.42349	45.93
Carnarvon	FPQ-6	CRO	-24.89740	113.71608	203.41
Eglin	FPS-16	EGL	30.42177	273.20189	91.86
Grand Bahama	FPS-16	GBI	26.61579	281.65215	45.93
Grand Bahama	TPQ-18	GBI	26.63636	281.73229	39.37
Grand Turk	TPQ-18	GTI	21.46289	288.86789	91.86
Hawaii	FPS-16	HAW	22.12209	200.33462	3740.16
Merritt Island	TPQ-18	MLA	28.42486	279.33560	39.37
Patrick	FPQ-6	PAT	28.22655	279.40017	49.21
Pretoria	MPS-25	PRE	-25.94373	28.35849	5334.65

*All quantities are referenced to the Fischer Ellipsoid of 1960.

Table B-2. C-band Station Locations (Continued)

Station	Radar Type	Identification	Latitude* (deg)	Longitude* (deg)	Altitude* (deg)
San Salvador	FPS-16	SSI	24.11883	285.49586	16.40
Tananarive	FPS-16	TAN	-19.00079	47.31505	4337.35
White Sands	FPS-16	WHS	32.35822	253.63044	4041.99
Woomera	FPS-16	WOM	-30.81973	136.83699	495.41

*All quantities are referenced to the Fischer Ellipsoid of 1960.

Table B-3. USBS Station Locations

Station	Antenna	Identification	Latitude* (deg)	Longitude* (deg)	Altitude* (deg)
Antigua	30'	ANG	17.01692	298.24715	141.08
Ascension	30'	ACN	-7.95506	345.67242	1843.83
Bermuda	30'	BDA	32.35129	295.34182	68.90
Canary Island	30'	CYI	27.76454	344.36519	567.59
Canberra	85'	CNB	-35.58474	148.97658	3766.40
Carnarvon	30'	CRO	-24.90759	113.72425	190.29
Goldstone	85'	GDS	35.34169	243.12670	3166.01
Grand Bahama	30'	GBM	26.63286	281.76234	16.40
Guam	30'	GWM	13.30924	144.73441	416.67
Guaymas	30'	GYM	27.96321	249.27915	62.34
Hawaii	30'	HAW	22.12490	200.33501	3772.97
Madrid	85'	MAD	40.45536	355.83261	2706.69
Merritt Island	30'	MIL	28.50827	279.30658	32.81
Texas	30'	TEX	27.65375	262.62153	32.81

*All quantities are referenced to the Fischer Ellipsoid of 1960.

Table B-4. Drag Summary

Vehicle	Time Interval From (hr:min:sec)	Time Interval To (hr:min:sec)	Vehicle Weight (lb)	Vehicle Area (ft^2)	Drag (ft^2/Slug)
CSM	15:23:28.9	21:36:57.6	25,642	129.35	0.1614
CM	21:36:57.6	Entry	12,505	129.35	0.3310

Table B-5. Radar Data Weighting

Data Type	Type of Radar	Weighting
R:A:E	FPQ-6	60 ft: 0.0258 deg: 0.0258 deg
R:A:E	TPQ-18 and FPS-16	90 ft: 0.0354 deg: 0.0354 deg
R:A:E	MPS-26	180 ft: 0.1720 deg: 0.1720 deg
R:X:Y	USB: 30-ft antenna 85-ft antenna	90 ft: 0.1375 deg: 0.1375 deg
Doppler (2 way)	USB: 30-ft antenna 85-ft antenna	0.2 cycle/sec

APPENDIX C

METHODS OF ANALYSIS AND PROGRAMS

This Appendix outlines the methods of postflight trajectory analysis and describes the major programs used in this work.

Orbit Reconstruction Programs

Low-speed tracking data for a mission are received from MSC on a magnetic tape. The data tape is input into the Master Tape Generator (MATAG) Program which reformats the data into a format that is compatible with the TRW orbit determination program (ESPOD) and generates a time-ordered master data tape. The master data tape is then input into the ESPOD Data Generator (EDG) Program which edits the master data tape and outputs the data in the form of tape or cards.

The ESPOD Program determines the state vector for a spacecraft at a given epoch and the covariance matrix of uncertainties. This is accomplished by an iterative process which minimizes the weighted sum of the squares of the residuals, where the residuals are the difference between the actual observations and the computed observations based upon a current estimate of the spacecraft trajectory. ESPOD also has the capability of including in the solution vector such parameters as drag ($C_dA/2m$), radar errors, and station location errors.

There exist two versions of ESPOD, both of which have the general capability described above. The USB ESPOD is distinguished by the fact that it can process RAER, $\dot{R}$XY, and doppler radar tracking data. It does not, however, have the capability of modeling burns. The IGS ESPOD, in contrast, can only process RAE$\dot{R}$ radar tracking data even though it does have two burn models, the LOP burn model and the IGS burn model. The LOP burn model uses an analytic thrust acceleration model - constant thrust oriented along the roll axis. Thrust/mass ratio, and orientation of roll axis are some of the parameters that can be included in the solution vector. The IGS burn model uses an acceleration burn tape based on telemetered data which is then input into ESPOD. Accelerometer and gyro errors may be modeled or included in the solution vector.

After a best estimate of the trajectory (BET) is obtained in ESPOD, a trajectory tape is generated and input into the RTCC Comparison Program. This program compares the RTCC trajectory and the BET by means of state vector differences exhibited in various coordinate systems. The total difference in position and velocity is also listed.

Guidance and Navigation Programs

The spacecraft trajectory during thrusting periods after S-IVB separation is reconstructed from inertial measurement data telemetered from the guidance and navigation system. Before an accurate reconstruction can be undertaken, it is necessary to determine the systematic errors present in the guidance system hardware so that appropriate corrections to the IMU data can be made. This procedure for trajectory reconstruction may be divided into three general areas.

Data Processing

The three sources of trajectory data used in Apollo IMU evaluation must be formated so that they are compatible with the trajectory computing programs.

a) The G&N Processor Program is used to edit Apollo downlink telemetry data and produce a regular ephemeris of measured position, velocity, and acceleration.

b) The S-IVB Processor Program is used to interpolate the S-IVB IU trajectory to the AGC/LGC time base and rotate the data into appropriate coordinate frames.

c) The General Data Processor Program is used to smooth, interpolate, and rotate high-speed tracking data (GLOTRAC, C-band) to an appropriate time base and coordinate frame.

IMU Evaluation

Determination of the systematic errors present in the Apollo guidance system is based primarily on comparisons of the trajectory (sensed and total) as measured by the AGC/LGC, with S-IVB and GLOTRAC trajectories. The boost phase of any mission is the most important for this analysis because of the relatively long time duration with high acceleration

levels. The two principal tools used in IMU error analysis are discussed in the following paragraphs.

a) The Error Analysis Program (EAP) is used to compute the partial derivatives of sensed position, velocity, and acceleration ($\partial Ps/\partial Ek$, $\partial Vs/\partial Ek$, $\partial As/\partial Ek$) with respect to each of the error terms, E_k, in the Apollo IMU error model. The input which drives the EAP is the edited ephemeris of sensed acceleration obtained from the G&N Processor Program.

b) The Velocity Comparison Program (VELCOMP) corrects the Apollo sensed trajectory profile using the EAP partials and the best estimates of the IMU errors, E_k. It then compares the corrected trajectory (in both sensed and total coordinates) with external reference trajectory data (S-IVB and GLOTRAC). The recovered set of IMU errors must, of course, be compatible with the preflight test history of the onboard guidance system and with the known trajectory constraints during later phases of the mission.

Trajectory Reconstruction

During thrusting periods for which limited external trajectory data are available, a different technique for trajectory reconstruction is employed. This method relies on two external inputs: (1) the set of IMU hardware errors determined from ascent analysis and (2) an accurate state vector, (P_o, V_o), from the ESPOD program to initialize the total trajectory. The Trajectory Reconstruction Program is driven with the outputs of the G&N Processor and EAP Programs. At time, t_i, the total corrected velocity is computed from:

$$V_{Ti} = V_o + V_{si} - \sum_K \frac{\partial V_{si}}{\partial E_k} E_k + V_{Gi}$$

This quantity is integrated to obtain total position, P_{Ti}, which is extrapolated to time, t_{i+1}, for the next computation of velocity due to gravity, (V_{Gi+1}).